THE

ELECTRICAL REVIEW.

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LIGHTNING EXPRESS RAILWAY SERVICE.

A HUNDRED AND TWENTY to a hundred and fifty miles an hour! London to Paris in two and a-half hours (*via* the Channel Tunnel)! London to Liverpool in one hour and twenty minutes; London to Edinburgh in two hours and forty minutes; and at like speeds to and from all important centres! Such is the programme set forth as within the realms of possible accomplishment in an apparently well-considered pamphlet by Mr. F. B. Behr, A.I.C.E., with an advance proof of which we have been favoured. Having thus set out the pace, the author proceeds to consider how this is to be accomplished. A certain mode and means of travel is at present in operation. Railways exist—a speed of 60 miles, and, on exceptional occasions, 70 miles an hour has been attained by the locomotive. Is it possible to attain, with due regard to economy, such an extension of speed as in the mind of the author is here set forth? The answer is, No. Is it possible to utilise the track now employed for the steam railway for any other form of motive power by which the increased rate of travel may be achieved? Again, the answer is, No. Increased rate of speed means around curves increased centrifugal force, an enlarged radius, and a greater super-elevation for the restraining rail. The largely increased rate of speed also suggests the propriety of the abandonment of all such things as level crossings, or other possible obstructions to the flying vehicle. We have to deal with a rate of speed two and a-half or three times greater than that of our fastest expresses. To intermingle trains at such speed with others of the prosaic pace of the present day would be attended with no economy, even were it otherwise admissible.

The next point considered is that which is needed in order to ensure safe travelling at such a rate. The Lartigue system is that approved. This, as our readers will no doubt be aware, consists of a single rail mounted on a conical girder frame in the shape of the letter A, the girder framework being mounted on sleepers or trestles, according to the formation required, in the same manner as the sleepers of the present day carry the iron chairs which support and keep in position the rails which form the track for the railway trains. Some 2 feet below the surface of the supporting rail the trestle is consolidated by cross-bracing, and here there is provided on either side a guide-rail, the purpose of which is to secure the equilibrium of the travelling vehicle. This vehicle is seated on a longitudinal centre plate, running on a single row of wheels over the axis of the wedge or cone-shaped framing, on each side of which the cars are placed. The permanent way has, therefore, a continuous triangular section, braced longitudinally and diagonally at the trestles. At obstacles to be avoided, such as roads, rivers, ravines, &c., special trestle piers are erected—in fact, the track has to be constructed, so far as its basement is concerned, precisely as would be the case for an ordinary line of railway, bearing in mind that a clear run, free from obstacles, is the point to be achieved. Here the author enters into a full consideration of strains and stresses based upon the speed to be observed, all of which will no doubt be of great interest to the railway engineer, but which space will not admit of our incorporating

here. Sufficient to say, the conclusion arrived at is to the effect that on curves of 25 chains radius, it would be impossible to adopt a sleeper of the requisite length, and that it would be preferable to anchor the structure to a suitable foundation. It is concluded that the description of car to be employed—a fully loaded 25-ton car—impelled by electrical energy, will never subject the permanent way to shocks or vibrations at all comparable with those to which ordinary lines are subjected by the swaying and jerking of a train formed of several vehicles drawn by a steam locomotive.

Coming now to the question of rolling stock, we have already intimated that a 25-ton car is to be employed. This car is to be in every way self-contained. Its essential feature is a framing carried on several wheels, placed on the same longitudinal axis. On each side of this frame are the compartments of the car, communicating across the central wedge-shaped longitudinal division by stairs placed at each end. It will thus be observed that the passengers find their seats facing the side of the vehicle; they, in fact, face the outlook, and sit sideways to the direction of travel. The means of ingress and egress are from the side of the vehicle. The driver's cabin is in front of the car, above and across the rail. Here he is to have command of all the gearing or whatever means may be needed for controlling the movements of the vehicle. But one vehicle for each train is to be used, and its accommodation would serve 100 passengers with luggage, the luggage being stowed in the lower portion of the vehicle, below the level of the passengers' seats. It is proposed that the breaks shall come into action automatically in case of any failure of the dynamo, as well as under the influence of the driver, and that any deficiency of brake shall be met by reversal of motors.

Electrical power being used, any number of motors may be installed, each operating its own running wheel, or which may be connected, if need be, as are the wheels of locomotives. The power required would, of course, vary with the load, gradient, condition of weather, &c. Mr. Behr gives the following as the result of calculation, based on a 25-ton car :—

Inclination.	Speed, 13 miles per hour. H.P.	Speed, 155 miles per hour. H.P.
Horizontal ...	100 ...	116·6
One in 200 ...	200 ...	233·3
„ 100 ...	300 ...	350·0
„ 50 ...	500 ...	583·3
„ 40 ...	600 ...	700·0
„ 33·3 ...	700 ...	816·6
„ 28·6 ...	800 ...	933·3

The vehicle being carried on eight equally loaded wheels, each wheel will possess an adhesive power of from 2¼ to 3⅛ tons, according as the load varies from *nil* to full load.

Cars, it is proposed, should follow at intervals of 2 to 5 minutes. At the termini the line would form a loop, so that a vehicle having arrived would run round the loop, and thus be in the proper direction for the return journey.

Mr. Behr does not enter by any means largely into the electrical branch of the question. He asks for so much power—so much energy to drive his vehicle, but he says very little—indeed, we might say, nothing as to how he would generate it, or to what length sections he would confine its distribution. From an approximate estimate of the cost of a line 64 miles long, we, however, see provision is made for "dynamos and electric fittings per carriage, £1,200," and for electrical generating stations complete at, say, £5,000 per train, or for 12 trains working simultaneously, £60,000. We take it, therefore, that the distribution sections would be some five miles in length—2½ miles on either side of the generating plant. The mode by which the current is to be conveyed to the motors of the travelling trains, its pressure, possible volume, &c., is not commented upon. As electricity is to be the primary agent, however, the mode of handling it demands much consideration, and will have to be dealt with ere the question can be fairly considered. It is the prime factor, and we should have been glad had Mr. Behr enlarged upon it.

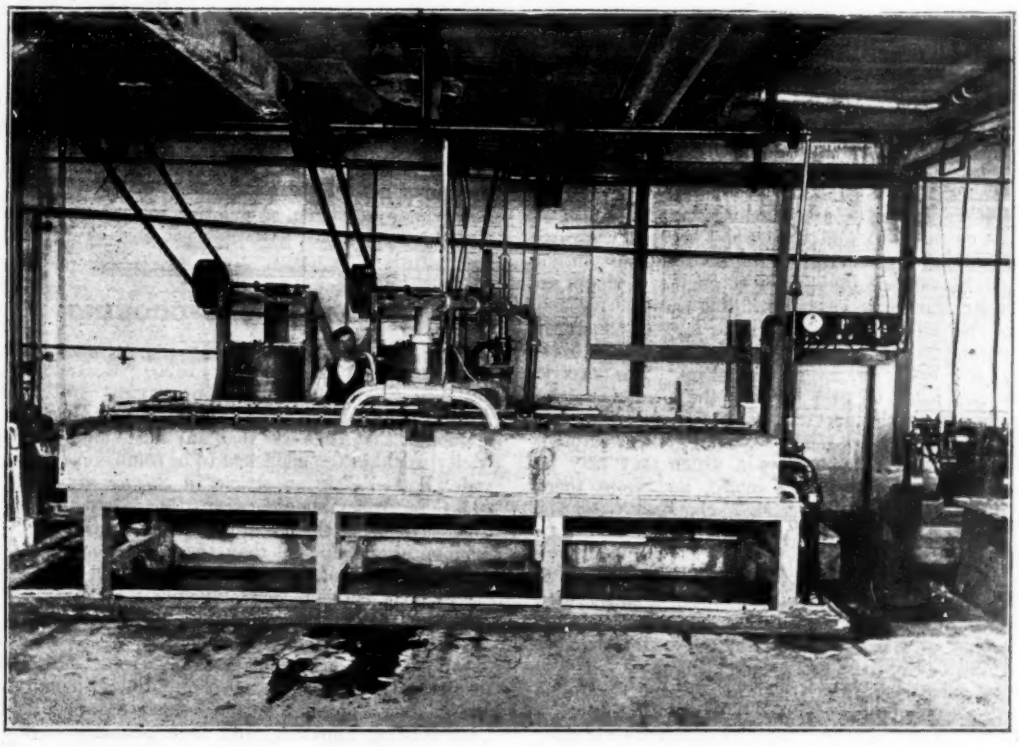
The first question to be considered in relation to this proposal is the need for more rapid locomotion. Is it needed? We think that is quite an open question. Doubtless there are, and always will be, a class anxious to beat the record: whatever may be accomplished, they strive to accomplish something better. But whether the great mass of the travelling public desire—and, if they had the means, would seek—to travel at a more rapid rate than is now at their disposal, we much doubt. Put the question in reference to London and Liverpool. Is it probable there would be some 20,000 people who would daily prefer to travel between these points at the enhanced speed of 150 miles an hour, rather than by the well-appointed trains of the present day at a speed of, say, 50 miles an hour? We doubt it. That electricity may, and will, become a useful agent in rapid traction we have every reason to expect. The generation of power to be converted into electricity for use within limited spheres can even now be effected at a cost considerably less than that evolved from the railway locomotive. But let us commence by degrees. Let us prove its economy over the locomotive. There is much to be said for it. The space occupied for generating stations will not, we have reason to believe, be greater than that now demanded for locomotive sheds. The central rail—although an ugly and somewhat inconvenient arrangement, so far as internal comfort is concerned—arranged so that the centre of gravity is above the load, must be safer than any of our present two-rail systems. With electricity there ought to be such automatic control as should preclude any possibility of collision. Derailment and collision eliminated, we pass beyond the source of many accidents under our present system. If such a system can be productive of economy at a speed equal to that of the present day, or greater, if called for, there will not be wanting opportunities to test it. Railway extensions are of almost daily occurrence. Trunk lines are fast doubling their busy lengths. Nearly all the chief lines into London are now using or providing not less than four lines. Mr. Behr's proposal that the slopes of embankments or cuttings may be utilised for fast through trains is worthy of consideration—in fact, the data which he puts forward, although in some points incomplete, and otherwise tinged with the ambition and enthusiasm of an inventor and advocate, should be read. If he can accomplish 150 miles an hour with economy, he can probably accomplish an honest 50 with equal economy, which will no doubt quite satisfy the demands of the day, whatever we may arrive at in the future.

We think it probable that, should Mr. Behr's proposals ever take root, he will find it necessary to largely modify his present proposals—for instance, his proposal to arrange the motors in the centre of the vehicle, between the passengers on either side, would, we should imagine, prove so disagreeable in many ways to the passengers, as to make it quite inadmissible. Closed carriages, with fixed windows, would be unbearable. To oblige a person to sit facing the windows would probably not prove agreeable to many. One drawback of the central rail is the need for equalisation of load on either side. Overloading on either side, of course, means increased lateral friction—undesirable, although perhaps not a very large factor. Mr. Behr gives his reasons for placing his motors in the car, and they are worthy of consideration; nevertheless, we are of opinion that it will be impossible of satisfactory application; the motor or motors will have to be placed in an independent vehicle. Connecting chains, buffer springs, and other coupling gear may have to be modified—probably would, if a higher rate of speed were attained—but to place the motor machinery in the car itself would be a mistake in many ways. Mr. Behr's proposals are an innovation, but, having regard to the fact that electricity is destined to play an important part in the future locomotion, we heartily commend his observations to the consideration of all who are interested in the question.

ELECTROLYTIC CAUSTIC AND BLEACH.

The electrolytic plant here described, and which has been devised by Mr. E. Andreoli, who operates it at Bethnal Green, is not merely intended for the production of chlorine and caustic soda, as, with a few modifications and by using special anodes, Mr. Andreoli can adapt it to the manufacture of chlorates, or of oxygen and hydrogen, &c. We confine ourselves to technical details on the construction of these electrolysers, but we shall have shortly an opportunity of investigating the working and of giving figures as to the E.M.F. required, and the yield of chlorine and caustic soda per ampère hour, and to see how it compares with the processes of Messrs. Richardson & Holland, Greenwood, Le Sueur, Hoepfner, and others.

In Mr. Andreoli's electrolytic apparatus, the porous diaphragm used is made of powdered asbestos, which, baked at a very high temperature, gives an exceedingly porous porcelain, presenting the advantages of offering less electrical resistance when saturated with brine than the ordinary porous clay porcelain, besides not being disintegrated like the latter, which swells and cracks very quickly when used in a tank for the preparation of chlorine and soda.



Experimental Electrolysis at Bethnal Green.

The use of this asbestos porous porcelain in electrolysing salts ensures the total separation of the anolyte and catholyte, which, being charged respectively with chlorine and caustic soda solution, do not intermingle, thus causing losses by recombination and formation of other salts, such as chlorates, &c., which are uselessly electrolysed, and further diminish the efficiency of the electrolytic operation. To maintain the yield of chlorine and caustic soda, Mr. Andreoli's tanks are constructed so that both anolyte and catholyte are continually circulated by pumps and cooled, and, if necessary, strengthened by the addition of salt in their passage from one tank to the other.

The anodes used are of dense retort carbon which is cut into slabs of about 14 inches by 6 inches. Generally retort carbon cannot be obtained in large slabs, and is, therefore, practically unavailable. It is, also, always difficult to connect the carbon anodes together without exposing the metallic contacts to corrosion by chlorine and oxygen; but Mr. Andreoli's tanks being shallow, it is easy to find pieces long enough to touch the bottom. The slabs of carbon at their top corner have two shoulders leaving a protruding piece, which, after being trimmed, is fitted in a hole cut in the slate lid of the positive compartment. A groove is cut in the upper part of the anode, the top of which is coppered and tinned, and the contact bar is fixed on it. Round the groove a paraffined string or cord prevents the carbon from being loose, and, also, the escape of gas from the positive compartment. To increase the conductivity of the anodes two or three holes are drilled vertically down the slab three inches deep, a copper rod is dropped in and the hole is filled by pouring in molten lead.

The cathodes are plain iron plates with holes punched in them to insure a perfect circulation of the alkaline liquor.

To diminish as much as possible the electrical resistance of the tanks, the anodes and cathodes are placed as close to the porous diaphragms as possible, so that except at the ends of the tanks each compartment has two sets of anodes and cathodes; on the side facing the porous diaphragms and the cathodes, the carbon pieces are carefully ground.

There are several modes of constructing extremely simple and cheap tanks; at Bethnal Green the following model has been adopted for the demonstration of the production of chlorine gas and caustic soda; these tanks have been designed by Mr. Cornelius Hanbury. They are made with two transverse chambers. Our illustration shows two electrolysers united together by two slate caissons through which, respectively, flow the chlorinated electrolyte of the positive compartments and the alkaline electrolyte of the negative compartment.

The tanks are not deep so as to facilitate the construction and the arrangement of the carbon anodes in their compartments, but they may be as long as desired.

Near the two opposite ends, partitions are fixed, cutting off two narrow transverse chambers; between these partitions, and at right angles to them, porous diaphragms, each with an anode and a cathode very close to it, are fixed so as to form narrow watertight compartments, which contain alternately, except in the first and last, two positive and two negative electrodes respectively. Each of these transverse chambers is divided into two, an upper and a lower one, by a horizontal partition fixed and made watertight at about one-third of the way up from the bottom. Thus, for instance, the upper chamber on the left side will be a positive chamber, and that on the right will be a negative; while the lower chamber on the left will be a negative, the one on the right being a positive. This means that the liquid in the positive chambers goes to or comes from the positive compartments,

and the negative chambers will contain the liquid which goes to or comes from the negative compartments. These transverse chambers are devised to feed the positive and negative compartments, and, also, to collect the liquid and gaseous products, and to maintain the circulation of the electrolyte.

In the space corresponding to every other compartment, a free aperture is made near the top of the partition at one end of the tank, the lower edge of which dips just below the intended level of the electrolyte, and the partition at the other end is similarly perforated near the top in the spaces corresponding to the other alternate compartments.

At the bottom of each transverse partition, free openings are made between alternate compartments and the lower transverse chambers, the openings in this lower series alternating with the openings in the upper series. Each compartment is shut in by a closely fitting cover. At one end of each of the upper transverse chambers, an opening is made through which the gas evolved is drawn off.

To each upper transverse chamber, a pump is attached, which forces the electrolyte through a pipe to the corresponding lower transverse chamber at the other end or side of the tank.

A similar result may be obtained by not subdividing the transverse chambers into upper and lower ones by horizontal partitions, but substituting for the lower transverse chambers, pipes continued from the pumps and connected to the positive and negative compartments respectively.

The characteristic novelty of this tank is that it constitutes a perfect *ensemble* in which works a double circulation of liquids, which instead of being sent as usual into special cisterns, whence they are forced into the compartments of the electrolytic apparatus, constantly circulate from the inlet to the outlet of each series of positive and negative compartments. It will be seen from this description, that the solution passing from the feeding tank, flows through two pipes into the two lower transverse chambers filling the positive and negative compartments till they reach the level of the upper openings mentioned above, through which the liquid overflows into the upper transverse chambers. The electric current is then made to pass through the electrolyte, the pumps connected to the upper transverse chambers are set in motion, drawing off the solutions, forcing them through the pipes and through the vessel in which they may be strengthened with fresh salt and cooled, and from there into the corresponding lower transverse chambers (either of the same tank or the next in succession) again thence to repeat the same cycle.

Above the surface of the electrolyte in the positive compartments, and the upper positive transverse chamber with which they communicate, chlorine accumulates and is drawn off at one end of the upper positive transverse chamber through a pipe, or from any other convenient spot.

Hydrogen is liberated from the surface of the electrolyte in the negative compartments and is drawn off through a pipe near one end of the upper negative transverse chamber or from any other convenient spot, and the solution of caustic soda, when sufficiently strong, can be drawn off from a pipe at the bottom of the same upper negative transverse chamber.

The two tanks which have been fitted up as a model installation at Bethnal Green, are considered by Mr. Andreoli as quite sufficient to demonstrate the efficiency of the process.

On the right of the illustration is seen an Elwell-Parker 10 volts and 300 ampères dynamo. The engine on the left is used for driving the anolyte and the chlorine gas pumps, and also the stirrers in the two wooden tubs behind the tanks. These tubs are filled with milk of lime to absorb the chlorine pumped from the anode compartments by the ebonite pump next to them. Mr. Andreoli absorbs the chlorine in milk of lime so as to be able to check the amount of chloride of lime formed at any time during the operation, as absorption in the dry lime would involve too much time when making experimental runs of the apparatus, which means a reading every 5 or 10 minutes, and a double analysis of samples of the chlorine and soda solutions. It is obvious that the chlorine could be absorbed in the dry state just as well; it is drawn off from the top of the upper transverse chamber through an earthenware pipe.

The hydrogen evolved in the operation collects on the opposite side of the tank, and is for the present led out to the open air by pipes. The anolyte is circulated by means of a Doulton earthenware acid pump, and is forced through a series of drain pipes lying in running water, thus constantly cooling the chlorinated liquid. The catholyte is circulated by a small steam pump which is situated near the engine.

The two boxes at the ends of the tanks are placed over a small hole in the lid of the end anode compartment, and are filled with lime, so that if at any time the chlorine pump is stopped for a moment, by accident or otherwise, the chlorine gas passes through them and is absorbed until the pumps start again.

The advantages claimed in favour of this electrolytic plant, apart from those which secure the special construction and arrangement of tanks in which the circulation, the temperature, and the density of the liquid are properly maintained, are :—

That the retort carbon anodes, made of a single piece, offer a very large surface, and, after they have been submitted to a previous special treatment, do not present any metallic part which may be corroded. That the porous asbestos or similar porcelain causes only a very small resistance, is not readily attacked by chlorine and caustic, and that, moreover, there is no chlorine in the negative compartment, and no soda in the positive compartment. That the E.M.F. required is low, owing to the special qualities of the porous diaphragms fixed on slate frames, between and close to an anode and a cathode, so that in each positive compartment there are two anodes, each facing the porous diaphragm, and in each negative compartment two negative electrodes, thus securing a good conductibility.

Further improvements in the construction of tanks, as well as of some new diaphragms, and the general system for the economical production of chlorine and pure caustic soda, and also of chlorates, &c., have been patented by Mr. Andreoli.

ELECTRICAL COOKING.

Some years ago (in December, 1890) "R. A. F." (a contributor to *Science*) made some experiments with a view to determining the efficiency of electrical cooking, as the general opinion at that time was that any such employment of electricity would be too inefficient to be commercially practicable, and "R. A. F.," in an article in *Science*, says that he had reason for believing otherwise. These experiments showed conclusively that the use of electricity for cooking was more economical and efficient than the use of coal in an ordinary cooking stove, but, as it was the intention of that writer to take out patents on several points, these results were not published at the time.

Since 1890, the fact of the efficiency and low cost of electrical cooking has been generally recognised, not only theoretically, but also in practice. But although there are now at least a dozen companies engaged in producing electrical cooking apparatus, and their productions are finding their way into hotels, dining cars, steamers, and private houses, so far as the writer knows, there have not as yet been published any tests of the relative efficiency of the new apparatus and the ordinary cooking stove. For this reason the following results may be of interest, the more especially as the results show the truly awful waste of fuel at present taking place, and the direction in which improvement both in heating and cooking must be looked for.

Details of Apparatus used in making Test.—The cooking stove was of the ordinary type, the enclosed grate which holds the fuel being 12 inches long by 6 inches wide, by 6 inches deep. Area of top of stove, 7 square feet. Size of oven, 2 × 1·6 × 1·6 feet. Number of orifices on top of stove, six. Orifices, 8 inches in diameter. A damper is so arranged that the heat passes directly up the chimney, after passing the six orifices for culinary utensils, or may be directed around the oven, after passing two orifices only. The total radiating surface is 37,200 square centimetres, approximately, and the average all-day temperature, so near as could be ascertained, nearly 100 degrees C.

The box for electrical heating was a cube whose sides were one foot in length. It was of polished tin, but no attempt was made to render it more bright than it was when bought. The box was heated inside by passing a current of electricity through a coil of iron wire wound inside the box. The watts used in heating could be found by multiplying the current

passing through the coil by the difference of potential between its ends, a thermometer inserted in the box giving the corresponding temperature.

The total quantity of coal used in the stove, obtained by taking the average of several weeks, was 30 pounds per day. Taking the average value for the thermal equivalent of good coal, this would represent the production of 100,000,000 calories, and therefore the efficiency will be given by dividing the total number of calories of useful work obtained from the stove by 100,000,000.

We can divide the useful calories into three classes, which we will call the *c*, *r*, and *p* calories, the *c* calories being those actually used in cooking, the *r* calories being those used in raising the water in which the substance is cooked to a cooking temperature, and the *p* calories being those calories used in cleaning the cooking utensils, &c. In the case taken, the *c* calories amounted to approximately 30,000.*

The cooking efficiency, or the ratio of the calories used in cooking to the total watts in the coal, is therefore only ·03 (three one-hundredths of one per cent).

The *r* calories amounted to 435,000. Adding them to the *c* calories, we get the total cooking efficiency to be ·46 (46 one-hundredths of one per cent.).

The *p* calories amounted to 2,256,000 approximately. Adding them to the *c* and *r* calories, we get the total all-day ratio of the useful watts to the total calories in the coal to be 2·7 per cent.

The addition of the calories used in heating a hot water apparatus for baths, &c., adds about 1·5 per cent. to the efficiency, making the total all-day efficiency of the stove above 4·2 per cent.

The writer has been informed that Professor Tyndall, in a test of the efficiency of a stove, obtained the figure of six per cent. This, however, must have been the maximum efficiency, as, without the hot water coils (which were probably not in the stove tested by Professor Tyndall) the all-day efficiency can hardly reach 3 per cent.

There remain, out of the original 100,000,000 calories in the coal, about 96,000,000 to be accounted for. These evidently are lost up the chimney or are radiated out into the room. We may make a rough calculation of their relative and absolute amounts.

The total radiating surface is, as given above, 37,200 square centimetres. Taking the average difference of temperature between the stove and the room as 80 degrees C., and taking the coefficient of emissivity of the blackened surface of the stove as ·0004, we find for the total loss in radiation, for the day of ten hours, 64,800,000 calories. The remaining 30,000,000 calories must go up the chimney, or be left in the unconsumed coal.

We may tabulate the results thus:

1. Total amount of heat in coal	100,000,000 k.
2. Amount used in actual cooking	30,000 k.
3. Amount two plus amount used in raising water in which food is cooked to cooking temperature	465,000 k.
4. Amount used in cleansing cooking utensils, &c. (2,256,000) plus amounts 2 and 3	2,750,000 k.
5. Amount used in heating bath, approximately	1,500,000 k.
6. Amount used in warming room	64,800,000 k.
7. Amount lost up chimney, and through incomplete combustion	31,000,000 k.

From these figures we see that the name cooking stove is really a misnomer, for of the total amount of useful work which is got out of the stove, *i.e.*, 69,000,000 calories, only 30,000, or about ·04 per cent. are utilised in cooking, the rest being spent in warming the room, and in heating water. It will be noticed that cooking stoves seem to be designed to present as much surface for radiation as possible, and that the efficiency of the stove as a water heater is only 4 per cent., while, with proper design, a water heater should have at least 50 to 60 per cent. efficiency.

The efficiency of the electric heater is very simply calculated.

A box, whose interior volume is 8 cubic feet, will cook the same amount as the stove experimented upon. The surface radiating heat will be, in this case, about 24,000 square centimetres, and, taking the emissivity at ·00025, we get for the total loss, since the current will be only used six hours, as against the ten of the stove (as no appreciable time is required to warm the electrical oven, and the current may be cut off when not in use), a total of 7,000,000 calories lost by radiation per day, when there is not a heat-retaining covering, such as asbestos, and the bare tin is exposed to the air. It would be only 55,000,000 in actual practice, as one side would rest on a table.

By the use of proper insulation, the loss can be reduced to one-tenth of this, or 700,000 calories. We thus obtain the following table:

1. Amount used in actual cooking	30,000 k.
2. Amount lost in radiation	700,000 k.
Total cost at 1 cent per 100,000 calories (which is the actual selling price of the electric companies at present, or slightly above it, in some cities)	7·3 cents.

If we include the amount of heat used in heating the food up to cooking temperature, we get:

1. Amount used in actual cooking plus amount used in heating up to cooking temperature	465,000 k.
2. Amount lost in radiation	700,000 k.
Cost at 1 cent per 100,000 calories	11·65 cents.

If we include the amount of heat used in heating water for cleaning kitchen utensils, water for bath, &c., we get the following:

1. Amount used for cooking plus amount used for heating to cooking temperature plus amount used for heating water for cleaning kitchen utensils, water for bath, &c. ...	4,250,000 k.
2. Amount lost in radiation	700,000 k.
Cost at 1 cent per 100,000 calories ...	42·5 cents.

The cost of the 30 lbs. of coal, at $6.00 per ton, is 8 cents.

We see, therefore, from these figures, that, so far as actual cooking is concerned, electrical cooking is about 10 per cent. cheaper than cooking with an ordinary stove.

When we use the electric stove to heat the water in which the food is cooked to boiling point, we see that electric cooking is 35 per cent. more expensive, if we take the ordinary prices ruling at present. As, however, a load due to cooking comes at a time of the day when a load is much desired by station managers, and would give a return at a time when the dynamos are practically doing nothing else, it is certain that there would be a deduction from the ordinary lighting rates, and the electric oven would compare favourably with the cooking stove under those conditions.

When, however, we come to use electricity as a means of heating water, for any purpose, we see that the electric cannot hope to compete with the ordinary method, uneconomical as the latter is. We are led, therefore, to the following, as the most economical method.

A boiler for heating water can readily be designed that shall have an efficiency of 50 per cent. This should be used for heating water, and also for heating the house, by means of the ordinary method of tubes. Means of effecting this combination will readily suggest themselves.

The electric oven should be used for cooking.

With this system we get the following table :—

1. Cost of electricity for cooking as above ...	7·3 cents.
2. Cost of heating water, for purposes as given above, and the same amount, in boiler of 50 per cent. efficiency, with coal at same price as mentioned above, allowing for loss through radiation for day of 12 hours	1·2 „
Total cost	8·5 cents.

It will thus be seen that there is practically no difference between electricity and the ordinary cooking stove, so far as cost is concerned, and it is almost needless to point out the advantages of the electric oven over the cooking stove.

In the first place, we have absolutely no dirt, the electrical oven being lined with porcelain enamel, which can be cleaned with the greatest ease. In the second, we have practically no heat outside the oven to heat the room in summer. Then we have absolute regulation of the temperature. If the oven is cold, and we require a temperature of, say, 100 degrees C. to cook something, the automatic regulator is set to 100, and in less than a minute the temperature has risen, and remains exactly at that temperature. Again, if it is desired to only

* The *c* calories were obtained by weighing the food before and after, and taking the loss in weight as due to evaporated water. This, of course, is not strictly accurate, but it must be a fairly close approximation.

cook for a certain time, say two hours, the cut-out is set for two hours, and at the end of that time the current is either stopped entirely, or is lowered so as to give any reduced temperature that may be desired.

In conclusion, we may say that the electric oven is bound to come, if only on the score of convenience and accuracy. If cheapness were the only consideration, we should still be burning tallow candles or gas, but people, and especially the American people, will always decide in favour of what is most convenient, so long as the difference in expense is not so great as to form a serious burden, and the above data will, it is thought, show that, used in a proper manner, the expense of electrical cooking need not be seriously taken into account.

It will be seen that of every 100 tons of coal used in a cooking stove, 96 tons are wasted. It is difficult, of course, to get exact figures, but it is probable that the waste in the city of New York alone is not far from 1,000,000 tons per annum.

With the electric stove, though the cost does not greatly differ, yet by far the larger proportion of the expense is due to the labour, interest on plant, and canalisation, so that (taking the efficiency of the boiler, engine and dynamo as 10 per cent.) the electrical oven, for the same amount of useful calories, uses only one-fourth as much coal as the cooking stove, and from a social-economical point of view, is much to be preferred, for the more we can live on the world's interest, which is labour, and the less we draw from the world's capital of fuel, the better.

THE UTILISATION OF TOWN REFUSE FOR POWER PRODUCTION.

By THOMAS TOMLINSON, B.E., Assoc.M.Inst.C.E.

(*Continued from page* 336.)

Before considering the question of the disposal of sewage sludge with a view to its utilisation for power production, it will be well to ascertain what quantity per head of population per annum we may expect to have to deal with.

Here is a table giving the weight of sludge as swept from the tanks (containing 90 per cent. of water):—

	Population, 1886.	Sewage in gallons per day.	Sludge per 1,000 inhabitants, daily.	
			Cubic yards.	Tons.
Birmingham	490,000	13,000,000	1·19	0·95
Bradford ...	188,000	7,300,000	1·20	0·96
Burton ...	34,500	4,500,000	1·16	0·93
Chiswick ...	20,000	482,000	1·87	1·50
Edmonton ...	25,000	900,000	0·55	0·44
Leeds ...	320,000	10,000,000	0·39	0·32
Leicester ...	132,000	7,000,000 9,000,000	1·04	0·83
Wimbledon ...	24,500	700,000	1·79	1·43

From these figures we can deduce the average as 0·92 tons of unpressed sludge per 1,000 inhabitants per day, one-fifth of this or 0·184 tons is the daily yield of pressed sludge per 1,000 inhabitants: from this we can deduce the average yield as 1·34 cwt. per head per annum; but it runs up to 2 cwt. per head per annum, and in certain cases slightly beyond this. As we have taken the average yield of ashbin refuse at 4 cwt. per head per annum, we may say that the pressed sludge varies in general from one-third to one-half the ashbin refuse, *i.e.*, from 1⅓rd to 2 cwt. per head per annum.

The problem of refuse disposal, in a town or district with water carried sewage and collection of ashbin refuse, resolves itself, then, into this, how best to deal with about 4 cwt. per head per annum of ashbin refuse, and 1⅓rd to 2 cwt. per head per annum of pressed (or dried) sludge, so as to obtain such a return in power as shall in whole or part cover the cost of collection of the ashbin refuse, treatment of the sewage, and destruction of the ashbin refuse and sludge.

It is not in the least likely that the cost of collection of ashbin refuse and treatment of sewage will be covered; but the cost of destruction can be wholly or very nearly covered.

From the experiments described in the last article, it is clear that there are at least two possible ways of dealing with ashbin refuse and sludge together—one is simply to mix the two and burn them in a destructor, and the other, obviously, is to utilise the heat from the ashbin refuse to retort the contained gas from the sludge.

The first is the method adopted by Mr. Jones at Ealing, to whom belongs the credit of its introduction; the second has, so far as I know, never been tried, but deserves to be considered, since it promises storage of the available power, a point now recognised as of paramount importance.

At Ealing, the manner of procedure is as follows:—The sludge as swept from the tanks is pumped into a covered wooden sided enclosure, and into this enclosure the lighter and bulkier portion of the ashbin refuse is also put; after a time, by drainage and evaporation, the mixed stuff has become sufficiently dry, when it is dug out and fed into the destructor with the rest of the ashbin refuse.

The practical result of this simple method of dealing with the mixed stuff, as estimated by the consulting engineers for the electric lighting, Sir F. Bramwell and Mr. H. Graham Harris, MM. Inst. C.E., is equivalent to an evaporation of 800 lbs. of water per ton of the mixed stuff, and appears to be as good as is attainable in ordinary practical working, for ashbin refuse alone, so that the actual practical result is that the sludge is dealt with in the destructor without reducing the evaporation due to the ashbin refuse alone. As the dried sludge contains at least as much water as the pressed sludge, 50 per cent., it is evident that the contained gases must be largely utilised to attain this result, and largely, I think, in the fume cremator, because as the gas is given off at a very low temperature, it is pretty certain that it is given off in considerable quantities at the back of the fire, and passes unignited into the flues, being then ignited in passing through the cremator, which in this case becomes a very important factor in power production; this could, of course, be easily tried by testing samples of the gas in the main flue before reaching the cremator.

It is satisfactory to find that at Ealing on a total cost of 1s. 6½d. per ton for destruction (inclusive of sinking fund), there is stated to be a deficit of only 3d. per ton when the value of the clinkers, steam, &c., is allowed for, and this before the electric lighting plant is connected, and so before all the steam made is utilised, so that even now five-sixths of the cost of destruction is returned.

Before considering the other possible manner of utilisation, it is as well to make, with the apparatus before described, the following experiment:—After the gas from the sludge has ceased to come over, pass steam from the closed kettle in at the upper branch of one of the vertical T's before described, and collect the gas (over water as before) from the upper branch of the other T; it will be found that there will be collected at least another 0·16 cubic feet of gas from the 1½ ozs. of pressed sludge, equivalent again to 3,800 cubic feet per ton, the yield, of course, depending upon the amount of carbon in the sludge. The composition of this gas we know: it is a mixture of H, CO and CO_2, the latter being very small in amount so long as the passage of steam through the tubes is not excessive in amount (and so absorbing heat at a quicker rate than it can be supplied from outside); to guard against this it is only necessary to stop the flow of steam when the gas begins to come over in small bubbles, re-starting the flow after a very short stop. The residue is simply the lime (or other precipitant), and the non-burnable detritus.

Experimentally then we can obtain from every ton of pressed sludge:

3,800 cubic feet of gas, probably mostly consisting of hydro-carbons.
3,800 „ „ „ consisting of H, CO.

There would appear to be little doubt that this gas can be used in a gas engine with a value in power something between that of Dowson gas and coal gas, *i.e.*, between 1 I.H.P. for every 70 cubic feet, and 1 I.H.P. for every 22 cubic feet, *i.e.*, there would be a return in power lying between:

109 I.H.P. hours per ton of pressed sludge,
and 345 „ „ „ „ „

Or assuming the ashbin refuse to be in the proportion of 2

to 1 to the pressed sludge, then the return on the whole would lie between :

36 I.H.P. hours per ton of mixed stuff,
and 115 „ „ „ „

Now the estimated evaporative value at Ealing of the mixed stuff is 800 lbs. of water evaporated portion of mixed stuff, or, say, 40 I.H.P. hours per ton of mixed stuff.

It is unlikely that the value of the mixed gas would be so low as Dowson gas, since taking equal volumes of both, the Dowson gas would consist of 50 per cent. of valuable gases (H and CO) and 50 per cent. of diluent nitrogen, the mixed sludge gas would consist of 50 per cent. of valuable gases (H and CO) and 50 per cent. of valuable gases, probably hydro-carbons. The actual quantity is not, however, the point which makes the possibilities of this plan of refuse utilisation worth considering and the difficulties of its realisation worth facing, but its availability : the power output from your destructor plant will be of negligible importance so far as electric lighting is concerned, though for pumping or steady work it would be of value, so long as it is represented on your output curve from your central station by a narrow rectangle lying along the base of the curve, and will only be of any practical value when it caps your output curve.

There are doubts and difficulties of course ; the first is this : Is the waste heat from the ashbin refuse destructor capable of supplying the heat necessary ? Take it that for every ton of pressed sludge there are two tons of ashbin refuse, these two tons of ashbin refuse will evaporate 2 × 800 = 1,600 lbs. of water. The ton of pressed sludge contains 1,120 lbs. of water only, so that there is no doubt that the operation can be carried thus far, and as much farther as the heat necessary to evaporate 500 lbs. of water will go. The value of the resulting 3,800 cubic feet of gas depends on its value in a gas engine; if it be one-half the value of coal gas the result is nearly an equivalent total power to the total when the mixed stuffs are burned in a destructor, but in a more valuable form. The difficulties begin the moment we try practically to convert the residual carbon. I think these difficulties are not insuperable, and I am sure they are worth tackling, because in this, or some other form of storage, lies any possibility of large usefulness from the waste heat of destructors.

(To be continued.)

A RHEOSTAT FOR INCANDESCENCE LAMPS.

We thought it would be interesting, writes M. van der Wallen de Fernig, in *La Lumière Electrique*, to find out by experiment the economic value of a carbon rheostat intended to regulate the consumption of incandescence lamps.

This regulator, which was made in New York, consists of a movable copper key, A, capable of covering seven fixed contacts, B, made of the same metal ; these contacts are connected by copper wires to different points of a rod of carbon bent into a circle. The diameter of this rod is 5 millimetres.

The apparatus is provided with a lid pierced with ventilating holes, and the movable arm is manipulated by means of a button of insulating material, as shown in fig. 1.

We can, by means of this button, introduce into the circuit of the lamp a greater or less resistance. The object of our examination of this regulator was to determine for each rod of carbon introduced into the circuit of the lamps :

1. The strength, in ampères, of the current passing through the lamp.
2. The voltage at the terminals of the lamp.
3. The lighting power expressed in candles.
4. The resistance of the carbon rod introduced.
5. The total number of watts consumed.

With a battery of accumulators for a generating source, we placed in series a Hartmann and Braun ampèremeter, the rheostat to be tested, and an incandescence lamp : at the terminals of the lamp a Richard voltmeter.

The instruments were tested first. We ascertained the luminous intensity corresponding to each contact by means of observations made with the Bunsen photometer. We first used 16-candle lamps at 110 volts.

Fig. 1.

We took, as a standard, a Siemens 16-candle incandescence lamp at 110 volts. Considering the time occupied by our researches it is hardly likely that the luminous rendering of our standard varied during the experiments. Moreover, we tried it both before and after our tests.

These are the results obtained for one of the lamps tried.

	Ampères.	Volts.	Watts.	Candles.
First contact	·3	100	30	7·4
Second „	·3	100·5	30·15	8·5
Third „	·305	102	31·11	9·4
Fourth „	·31	103·25	32·00	10·3
Fifth „	·32	104·75	33·52	10·6
Sixth „	·325	108·25	38·15	14·5

On the seventh contact the carbon rheostat is out of the circuit.

The above results are the mean of a series of six lamps.

We then tried 16-candle lamps at 65 volts. The standard was a Siemens lamp of the same nominal value.

	Ampères	Volts.	Watts.	Candles.
First contact	·62	43·5	26·97	1·6
Second „	·651	46·0	29·95	2·5
Third „	·690	49·0	33·81	3·8
Fourth „	·725	51·2	37·12	5·2
Fifth „	·770	54·4	41·89	7·5
Sixth „	·770	54·4	41·89	7·5
Seventh „	·890	63·0	56·07	15·5

The 32-candle lamps at 65 volts gave the following results :

	Ampères.	Volts.	Watts.	Candles.
First contact ...	1·06	42	44·52	1·2
Second „ ...	1·10	46	50·60	2·5
Third „ ...	1·18	49·2	58·06	4·0
Fourth „ ...	1·22	53·0	64·66	6·9
Fifth „ ...	1·28	57·0	72·96	12·3
Sixth „ ...	1·28	57·0	72·96	12·3
Seventh „ ...	1·42	95·0	89·60	30·0

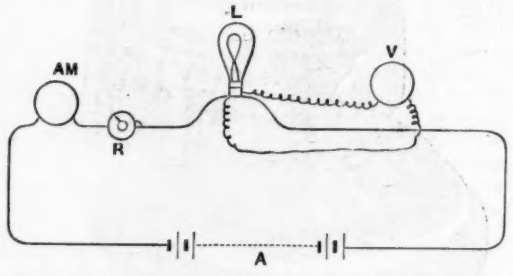
The resistance of the carbon filament when cold was determined on the Wheatstone bridge.

For the seven contacts we found respectively :

First contact	=	37·736	ohms.
Second „	=	28·293	„
Third „	=	23·576	„
Fourth „	=	17·925	„
Fifth „	=	11·783	„
Sixth „	=	11·783	„
Seventh „	=	10·085	„ (?)

C

We thought of measuring the heating of the carbon by placing it in contact with alloys fusible at known temperatures, but were prevented by the difficulty of procuring them. By putting water on the carbon we found that for the minimum intensity of current noted above, viz., ·3 ampère, the temperature is at least 100°.



AM, ampèremeter; L, lamp; V, voltmeter; R, rheostat; A, accumulators.

FIG. 2.

It will be observed from the tables that the apparatus was not well arranged: contacts 5 and 6 correspond to the same length of carbon.

Economy.—Let us take the case of a 32-candle lamp. The intensity of the current descends from 1·42 to 1·06 ampère, or ·36 ampère.

Of course this is not a case in which the apparatus should be employed, since we are seeking to reduce the consumption. The object of the apparatus is to keep up a reduced light sufficient for night surveillance, &c. In the case of the 32 candle lamp, the consumption is still 1·06 ampères.

It is more economical to mount the apparatus with a 16 candle lamp at 110 volts. The consumption falls ·025 ampère. For 1,000 hours this makes 25 ampère hours; reckoning the ampère hour at 5 centimes, the saving effected would be 1·25 fr.

The apparatus costing 15 fr., the money would be saved at the end of 12 years.

This rheostat-commutator may therefore be of some utility in private houses where different intensities may be given to the source of light, passing through all degrees. But if we wish to instal on the current at our disposal one lamp to serve simply as a night light, the object may be attained much more economically. Perfect regulation will be wanting, but our apparatus will have all the other advantages of the carbon rheostat: simplicity of construction, facility of connection, and absolute reliability. By means of a simple interrupter acting in two directions we can arrive at a much greater saving, both in the cost of installation and in the consumption of current. This is the little arrangement we propose to use, fig. 3.

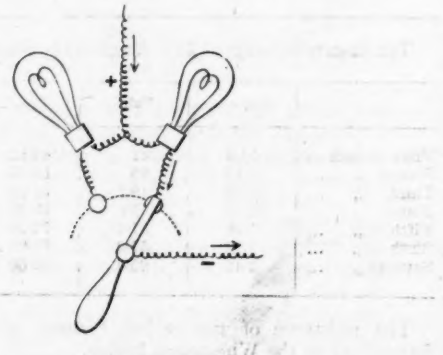


Fig. 3.

Possessing a source of current of 65 volts, we substitute for the rheostat described above, an interrupter acting in two directions, with which we connect two lamps, one of 16 candles at 65 volts, the other of 16 candles at 110 volts. The saving in the cost of installation is considerable, thus:

2 lamps at 1·20 fr.	...	...	...	2·40 fr.
2 sockets at ·60 fr.	...	...	...	1·20 „
1 interrupter acting in two directions			...	1·00 „
1 board	...	...	...	·20 „
¼ of a day's work at 6 fr.	...	...	...	1·50 „
Total	...	...	...	6·30 fr.

Saving = 15 − 6·30 = 8·70 fr.

The saving in the consumption of current is much more important. A 16-candle lamp, at 110 volts, takes at the source of current ·3 ampère, *i.e.*, ·525 ampère less than the same lamp at 65 volts. In 1,000 hours this makes 525 ampère hours at ·05 fr.; the ampère hour being reckoned as before, this amounts to 26·25 fr.

The luminous intensity is only ·3 of a candle, but this is sufficient for a night light; the lamp will show a clock placed at a considerable distance, and the interrupter can easily be found if the full light is required.

HIGH FREQUENCY DISCHARGES AND INCANDESCENT LAMPS.

THE possibility of incandescing the filaments of ordinary electric lamps by means of high frequency currents conveyed through the human body, has been demonstrated by Mr. A. A. C. Swinton [*vide* ELECTRICAL REVIEW, January 13th, 1893], who has given reasons for believing that the quantity of high frequency current necessary for this purpose must be much smaller than the quantity of continuous current required to produce a similar effect. In the *Philosophical Magazine* for September, 1893, he describes the following experiment which appears to be further proof of this:—

One pole of the high frequency coil being connected to one terminal of a 5 C.P. 100 volt incandescent lamp, two short wires were connected respectively to the other terminal of the lamp and the other pole of the coil, and arranged so that their free ends pointed towards one another, with an intervening space of about a quarter of an inch. In this space was placed a sheet of glass of sufficient size to prevent sparks passing round its edge, the whole arrangement being such as to form a condenser, of which the points of the two wires were the conducting plates and the glass the dielectric. On the coil being put in action, sparks spread out on each side of the glass so as to cover a circle about three inches in diameter, and the lamp filament immediately became incandescent. The capacity of a condenser of this description must be exceedingly small, even if we consider the acting surface to be represented by the whole area covered by the sparks, consequently, though the frequency is, of course, enormous, the actual quantity of electricity passing in the circuit must be very minute.

The heating effect of very small high frequency currents has received the following explanation from the Hon. Charles A. Parsons, and is given in the same paper:—

The total heat imparted to a wire is proportional to the average drop in volts between its ends multiplied by the total quantity of electricity passed, *i.e.*, by the number of coulombs. This follows from the usual formulæ:

$$E = C R; \quad \text{heat} = C^2 R = C E.$$

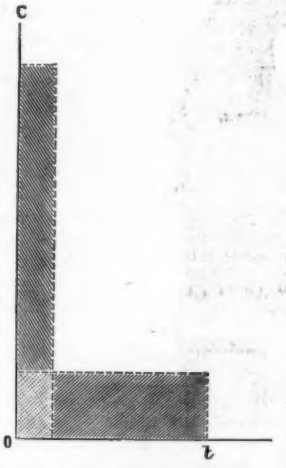
Eliminating time $\quad$ Heat $= Q E$.

Now if the volts be increased the quantity required to produce a given number of heat units is proportionately diminished. If a 100-volt incandescent lamp, taking ·6 ampère, be brought to incandescence by short impulses of current at 10,000 volts average pressure during each impulse, the quantity passed in any considerable time will be only ·01 of that which would be required were the 100 volts continuously applied for that time, or will be equal in quantity to ·006 ampère continuous current.

This may be expressed in another way. Assuming the resistance constant, we have—

$$\text{Quantity } \phi = \int C\,dt$$
$$\text{Heat varies as } \int C^2\,dt.$$

If, in the accompanying figure, the ordinates represent current, the abscissæ time, then the area of the figures $= Q = \int C\,dt$, the heat $= \int C^2\,dt =$ the moment of the figures about the line $0\,t$. Figures of "peaky" form have much greater moments about this line than figures of the same area but of flatter form.



The shaded figures represent equal quantities of electricity. The distances of the centres of gravity (which are marked by spots) from the line $0\,t$ represent the heating powers, which are proportional to the mean volts during each impulse. The converse of course follows, that if the heat be constant the quantity of electricity is inversely proportional to the mean volts during each impulse. The above is on the assumption that the effects of self-induction are negligible, as is probably the case with small lamp filaments. When, however, self-induction does exist a similar effect is produced, owing to the increased resistance due to this self-induction, as Mr. Swinton has already suggested.

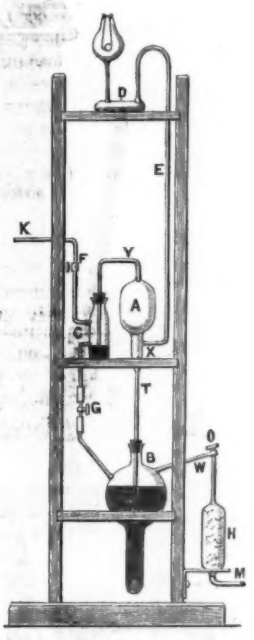
At the commencement of this paper several curious effects are described which were produced by means of high frequency discharges over the surface of resin, oil, alcohol, paraffin oil, and distilled water; and also an experiment illustrating the strong electrostatic effects produced in exhausted tubes by such discharges.

RANKIN KENNEDY'S VACUUM PUMP.

This pump was designed by Mr. Kennedy for exhausting quantities of incandescent lamps at one time. It was used at the Woodside Electric Works, Glasgow, and has been found very successful, and now that incandescent lamp making is about to be taken up by many firms a description of this pump should be of interest. It is exceedingly simple and most effective in working for high vacuums, and in a modified form is very handy for laboratory purposes.

The figure shows the form used for factory purposes. A is the pump bulb; B, the mercury reservoir; C, a mercury seal; D, the drying tube containing anhydrous phosphoric acid, the lamp branch proceeds from this tube, or any other vessel to be exhausted.

There are three ways of operating this pump, first, the one shown in the illustration, in which the distance from the surface of the mercury in B, to the top of the exhaust pipe, Y, is less than the barometer column, say 24 inches. To work the pump in this form the pipes, R and N, are connected to a mechanical exhaust pump, tap O is a three-way tap opening the bulb, B, to the exhaust pump or to the atmosphere through drying bulb, B. To begin the operation, K is opened by tap, F, to mercury seal, C, and tap, O, is opened to the atmosphere, the mechanical pump will then draw the air out of the pump bulb, A, seal, C, pipes, Y and E, tube, D, and lamp, up to a vacuum as good as can be obtained by a mechanical pump; this can be seen by the mercury rising from bulb, B, in tube, T, until it reaches junction, X, cutting off communication with E and D, the mercury then fills the pump bulb and drives before it all gases over the bend, Y,



and through the seal, C, into exhaust, K, any mercury coming over is returned by over-flow pipe, G, by opening the tap when a vacuum is made in B.

Immediately a drop of mercury flows over the bend, Y, tap, O, is closed to the atmosphere and opened to the exhaust pump, and as it is exhausted the mercury return sfrom bulb, A, and on emptying past X, opens pipe, E, tube, D, and lamps to the perfect Torricellian vacuum left in pump bulb, A. This cycle is repeated over and over again until the desired vacuum is attained.

Another method of working consists in making tube, T, so long that from surface of mercury in B, to junction, X, is at least 32 inches, or a little greater than ordinary barometer height, and applying a pressure pump to N, so that after the exhaust pump at K has exhausted the system until the column in T stands nearly at barometric height, an air pressure of 5 or 6 lbs. per square inch applied in B, sends the mercury into A and up to bend, Y. On then opening O to atmosphere and releasing the pressure from B, the mercury falls out of A and opens X, thus exhausting D, and the lamps into A, through E.

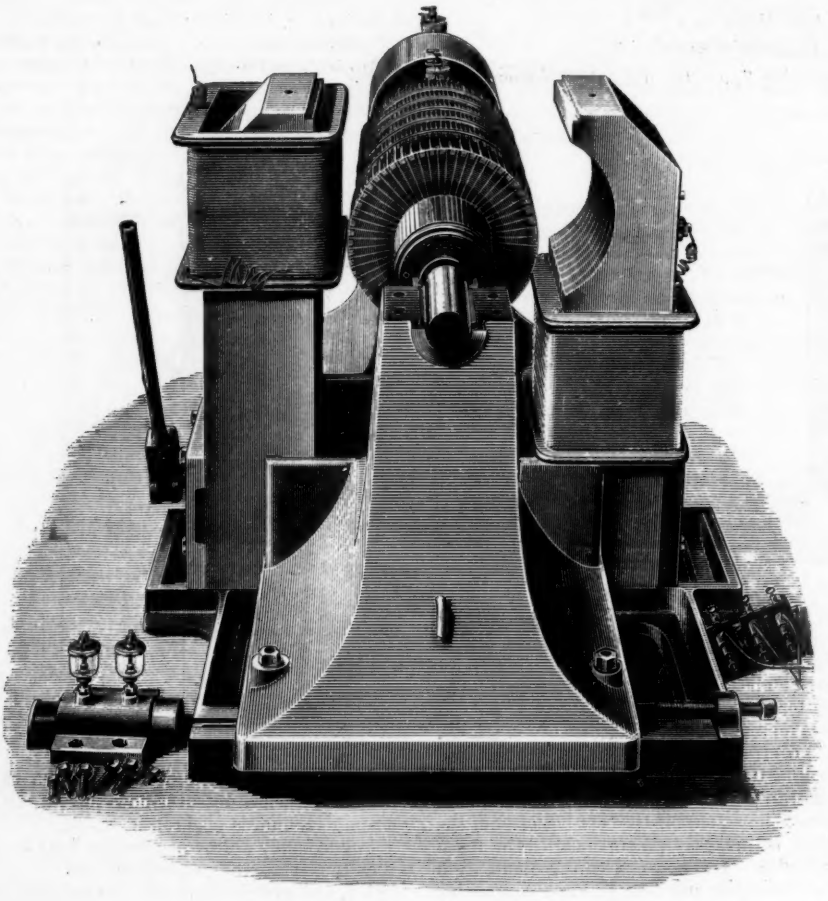
For laboratory work the bulb, B, is connected to pipe, T, by a flexible tube, and the overflow, G, is also made flexible. By raising and lowering the bulb, B, a distance of 8 or 10 inches, after the mechanical pump has exhausted the system as far as it can, the mercury will be filled into and emptied from bulb, A, and the pump will finish the vacuum in D and lamps in a very short time.

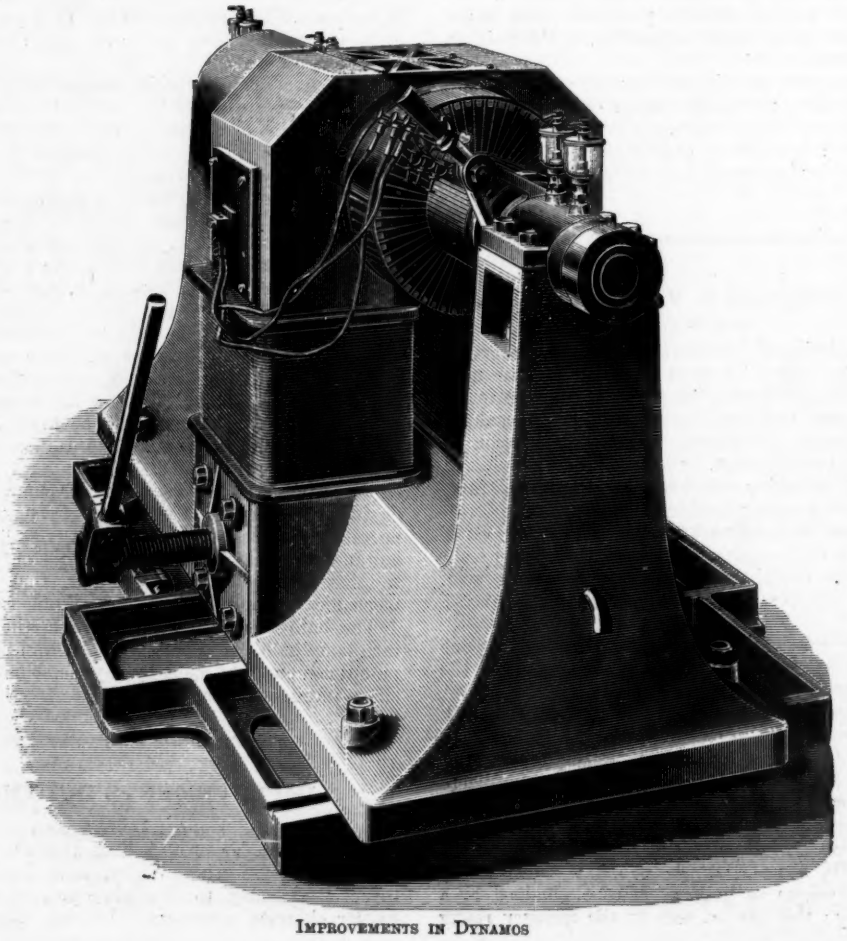
This pump is an improved Geissler pump, and in it no taps or joints are exposed to the perfect vacuum, and there are no valves whatever except the mercury seal, C, the taps, F, G, and O, never communicate with the mercury pump vacuum, so that although they may leak, that only affects the mechanical pump vacuum to a negligible extent.

The bulb is a five-inch lamp bulb, the bulb, *a*, a three-inch lamp bulb, the tubes are $\frac{1}{8}$th inch piecing tube. These pumps can easily be made by any glassblower who can finish off an incandescent lamp.

IMPROVEMENTS IN DYNAMOS.

Messrs. F. M. Newton & Tom Hawkins of the Newton Electrical Engineering Works, have lately taken out an invention relating to two-pole dynamos and motors, and similar electrical apparatus. In such machines there is a





Improvements in Dynamos

difficulty in removing the armature, which has usually to be threaded or carefully passed horizontally through the core of the magnets. The main objections to this are, firstly, that the machines must be spaced far enough apart to admit of the withdrawal, horizontally, of the armature when required, and, therefore, they cannot be placed close together, so entailing waste of space, which is often an important consideration. Secondly, the clearances between the armatures and magnets being small, there is serious liability in large machines, especially, of damaging the armature in removing or replacing it. Thirdly, before the armature can be removed horizontally in or out, its shaft bearings have to be removed, and, also, if desired to remove the field magnet coils, both armature and bearings must first be removed. The object of their invention is to obviate all these inconveniences, and to enable either armature or field magnet coil to be removed and replaced readily and easily, and by enabling the machines to be grouped close together to economise space.

For these purposes, according to the improvements of Messrs. Newton & Hawkins, one or both of the field magnets are arranged in such manner as to be capable of being slidden to and fro upon the bed-plate. This is effected by means of a suitable screw or screws adapted to operate the magnet or magnets which are mounted in a slide way as, and when required, said screw or screws being themselves actuated by a ratchet wheel and lever, or otherwise. Thus, when required to insert or remove the armature or a field-magnet coil, one or both field-magnets can be simply receded by the screw or screws, and by merely removing the armature shaft bearing caps the armature can be lifted vertically and bodily out of its position, and, so, also, can either of the field-magnet coils without in any way interfering with the armature or its bearings. The screw or screws, also, serve to hold the field-magnet in the proper position, and the magnetic circuit is closed through a suitable yoke interposed between the field-magnets.

CORRESPONDENCE.

Re Incandescent Lamps.

Your leader in last week's issue appears to us to state the case from one side only. Your well known fairness and desire to serve the general public leads us to hope that you will permit us to place before you the position as viewed from the other side. Without going into all the details, there are three important points upon which we wish to dilate.

1. *Minor Patents.*—We are well aware that the Edison-Swan Company possess a number of minor patents for which they have religiously paid the fees during the last 10 or 12 years, a fact for which the Patent Office authorities will be grateful. We do not doubt that there is sufficient in them that a case in law might be made out against such lamps which are not manufactured with due regard to the existence of these patents; but we are quite sure that an efficient lamp, equally as efficient as the Edison-Swan lamp, can be manufactured without in any way infringing the still existing patents. We, for one, are ready to supply purchasers of our lamps with the strongest possible guarantee against an action for infringement.

2. *Sanity of Capitalists.*—The writer of your leader makes the astonishing remark that he fairly doubts the sanity of capitalists who at present are laying down plant capable of turning out a million lamps per annum. As far as we know, we are the only firm who have advertised the fact of laying down such a plant, and we cannot help thinking that the shaft is thrust at us. We are glad to inform the writer that none of the capitalists who are supporting us in this undertaking at present show any signs or inclination which might qualify them as inmates of Colney Hatch. On the contrary, our capitalists and directors have deliberated this matter very fully, and whilst in possession of their full faculties. The factory above mentioned was built a few years ago by one of the leading electrical concerns in this country, and is laid out for an output of from 2,000 to 3,000 lamps per day, and one of the main reasons for our acquiring it was, that there is plenty of room for extending it to double or treble its present capacity. Upon this point we have always held opinions diametrically opposed to those of the management of the company who have had the monopoly of incandescent lamp making in this country. They, we believe, think in accordance with the spirit of your leader, which expresses the fear that the enormous quantity made will cause a serious deadlock. We entirely differ from this view, as we are not only thinking of the British Isles alone, but we intend to make a serious attempt to recapture the foreign and colonial markets, which, to the detriment of the general electrical trade, has been lost to England through the policy of the monopolists, which we may be permitted to call short-sighted. It is the case of the telephone business over again, where the policy of the monopolists has succeeded in throwing the telephone business of the world into the German and American markets. With this object in view we are not afraid of any output.

3. *Skilled Labour.*—We consider the remarks of your writer upon this point very wide of the mark. Anyone acquainted with the manufacture of lamps must know that the principal skilled labour and experience required should be vested in an experienced manager of the factory, one fully conversant with every detail.

Other skilled labour, such as required for testing, glass blowing, exhausting, burning in, &c., can not only be easily taught, but as we know from experience can easily be obtained in London; in fact, the numerous applications we have had lately show us that there is not a want, but a plethora of such labour.

Now, for what reason can the Edison-Swan Company be considered as being in a more advantageous position? Is it Mr. Edison or Mr. Swan who has the directing of their factory? These are certainly two names to conjure with, and no doubt that 99 out of every 100 of the general public are under the impression that Mr. Edison or Mr. Swan are the directing spirits of the company. If this were so, we would willingly take a back seat, but we in the trade know otherwise.

As regards Mr. Edison's position, we happen to know the actual facts. At an interview which Mr. Hirst had with him during his visit to the States in April last, Mr. Edison emphatically declared that he had absolutely nothing to do with the English Company, beyond having a few agreements with them; but for many years past he has heard nothing whatever from them.

As regards Mr. Swan we are not so well informed, but we believe his labours for a long time past have been in a direction other than lamp-making.

No doubt the Edison-Swan Company have experienced and able managers, but there are in existence other factories who have produced equally good men, who have gained their experience in foreign countries under the trying circumstances of severe competition, which may be a slight advantage over those who have gained experience under the protecting wings of a monopoly.

Before closing, we wish to state that this letter has not been written in any antagonistic spirit, or to detract from the quality of the Edison-Swan lamps in the past, present or future; but we could not help thinking your leader very one-sided, especially on these three points.

The Incandescent Electric Lamp Company, Limited,
AND
The General Electric Company, Limited.
G. Binswanger, *Director.*

"Electricity in the Home and Office."

A cutting from your Journal, dated August 11th, entitled a "Fancy Sketch," has been forwarded to me, in which you criticise most severely my article in the *Engineering Magazine* on "Electricity in the Home and Office," stating that it is Jules Vernian.

In justice to myself, I feel compelled to inform you that in the article in question I only mentioned devices to be seen every day in New York, the major part of the article being taken up with the description of a friend's house. Indeed, I carefully avoided referring to work which was even difficult.

People in this country have turned their "Yankee genius" towards making electricity do all kinds of things.

Frederic A. C. Perine.

What are the Best Books on Electricity and Magnetism.

If not against your rules of management, could you give or allow space in your columns for any of your readers to give me advice as what are the best books to study for electricity and magnetism honours under the Science and Art Examiners at South Kensington. I have first-class certificates for the same subject in both elementary and advanced stages, but cannot get any good reliable advice as to what books to get for the honours stage; the advice will be thankfully received.

J. Wilson.

[We think that the best plan undoubtedly is not to rely on one or two books to give the requisite information for the object our correspondent has in view, but to consult different works by well-known writers for different subjects. Thus, for methods and theory of measurements of magnetic permeability and kindred subjects, he might consult Prof. J. A. Ewing's "Magnetism in Iron and other Metals." Prof. S. P. Thompson's work on "The Electro-magnet" also contains some very instructive and easily read matter in this connection. Prof. Ayrton's "Practical Electricity" gives much needful information on various heads, and portions of Fleeming Jenkin's little text-book will come in useful. If our correspondent has access to a good science library he will have no difficulty in finding useful matter. It would, of course, be advisable to obtain the assistance of a competent tutor, and it is *indispensable* that he should have some practice in the use of such instruments as Wheatstone and metre bridges, reflecting galvanometers, quadrant and absolute electrometers, ballistic galvanometers, and the auxiliary apparatus required in making various measurements. For much of this practical work he cannot do better than follow out Stewart and Gee's "Elementary Practical Physics," Vol. II., in which there is also much else that is helpful. Let him not forget to practise answering questions.—Eds. Elec. Rev.]

Electric Plasters.

My attention has just been called to an article in your issue of October 6th, illustrated by a sketch of the simplest form of our electric plasters.

As your article might have been written or inspired by some one having a strong personal animosity to some member of this company, I appeal to your sense of justice to allow me a few words in reply.

This company being a legitimate business enterprise should not be confused with other enterprises where exorbitant prices are extorted for belts, batteries, &c., of very doubtful value. Our plasters are *the same size* and sold at the same price as other porous plasters, while excluding altogether the electric properties, we claim that in efficacy they are an improvement on others; and we also claim to have proved by actual experiment, that the electricity they generate, slight though it is, and temporary in its effects (all plasters are only applied for a very limited time) has very decided physiological effects. No doubt if you continue to gratuitously give us "bold advertisement," the pecuniary effects will be equally satisfactory.

Your article further implies that the plasters do not cost a "penny piece." The ingredients alone of the extract of "sickly green hue," which you recommend for drawing room decoration, would cost very much more than a penny each, so that with cost of cloth, metals, labour, and the 1½d. government stamp which each plaster has to have affixed, the cost must be very much more, so that it is evident your informer or correspondent must have very poor powers of calculation or discernment, and your readers will no doubt give his other assertions the same amount of credit.

Henry Mills,
(*Manager*) *Electro-Magnetic Plaster Company, Limited.*

[This letter comes at an opportune moment, for it allows us to enlarge upon our note of last week. It will have been noticed in our sketch that the copper and zinc are connected by a strip of the latter metal, uninsulated, so that copper and zinc are in actual contact in the electrolyte, that is, on the humid skin. We therefore have no hesitation in saying that the statement, "when applied to the body real and effective electric force is generated," is utterly untrue, so far as any operative effect on the body is concerned, and we trust that some steps may at once be taken to put an end to this misuse of electricity. Manchester papers please copy.—Eds. Elec. Rev.]

A Three-Cylinder Gas Engine.

I notice with considerable interest in your last issue a description of a three-cylinder vertical gas engine by Messrs. Weyman & Hitchcock. I am a firm believer in the future of gas power for all central station electric lighting, the gas to be produced by Dowson's generator, or some similar cheap gas apparatus. The recent monopoly in the gas engine trade has, however, much retarded the development of the gas engine, and it is only during the last few months that improvements in the right direction have been made.

It has been my endeavour for some time past to convince gas engine manufacturers that the high road to success lies in the multiplication of impulses and not in the employment of excessively high speeds and heavy fly-wheels. In response to suggestions made by me in the *Electrician*, of May 5th, Messrs. Dick, Kerr & Co., have manufactured an engine embodying the ideas I then expressed. This engine has two impulses per revolution, one for each beat of the piston. There is, therefore, a constant turning effort. The engine, which develops 80 brake horse-power, has been put down under my supervision for the Rugby Electric Light Company, Limited. It has just been started most satisfactorily, working with Dowson's gas and driving a 50-kilowatt Mordey alternator. The continuous impulses are produced by two double-acting cylinders placed "tandem fashion." There are, therefore, only two main bearings and only one connecting rod. This simplifies all parts forward of the cylinders very much. It is too soon to speak confidently about an engine that has only been running a few days; but when it has had a longer trial, I will publish the results.

The three-cylinder engine described in your last issue is also a decided step in the right direction. This, however, has only three impulses per two revolutions, not five impulses per three revolutions, as you put it. The vertical marine type should have much to recommend it, if sufficient stability can be obtained. The saving of floor space would be a great boon in many installations.

J. A. McMullen, M.I.E.E.

NOTES.

Personal.—We are pleased to see that the electrical engineer to the Glasgow Town Council (Mr. Arnot) has had his salary increased from £250 to £350 per annum.

Appointment.—Mr. J. E. Edgcome has been appointed resident engineer and manager at the electric lighting station at Kingston, at a salary of £156 per annum.

Government Telephone Exchange at Devonport.—The Admiralty have decided on establishing a telephone exchange at the Royal Naval Barrack, Keyham. The system will include a wire going as far seaward as Rame Head. The work will be completed in a few weeks, and will be the most extensive telephone exchange that the Government have at any port.

Lectures.—A special course of 30 lectures was commenced on the 2nd inst., at the Polytechnic Y.M.C.A., Regent Street, W., the subject being electrical engineering and experimental physics. The classes will continue throughout the winter, and will be conducted by Mr. W. Hibbert, F.I.C., A.I.E.E., who will be assisted by several other gentlemen. Arrangements have been made for lessons on a variety of kindred subjects, among these being, all about electric bells, electric lighting and distribution of power, electro-metallurgy, and electroplating. Full details *re* terms may be obtained from the secretaries, and we recommend intending students to secure a copy.

New Science Schools.—We understand that Lord Kelvin has consented to open the new science buildings at the Leys School, Cambridge, on Saturday, the 28th inst. These buildings include separate laboratories for elementary and advanced chemistry, biology, and physics, three lecture theatres, and an extensive museum.

The Demand for Electric Lighting at Dundee.—The demand for installations of the electric light has been steadily increasing in Dundee since the necessary works were completed. Of the 6,000 lamps which the present power can supply, as many as 4,000 have been applied for and are now being supplied, and it is expected that the remaining 2,000 will also be in use very soon.

Electric Light Lead Jointing.—The engraving shows a joint taken from a West End establishment. The wires are perfectly loose, and not even a wrapping of tape covered the defective workmanship. Two other lively specimens of

joints were taken from the same place the other day, and it is a wonder that the building was not long ago set on fire; it is now, however, being re-wired under proper directions. Such specimens as this ought to act as a warning to contractors to bestow a little more supervision over their *skilled* labour.

Electrical v. Steam Locomotives.—At the World's Fair the other week an interesting experiment was made to test the comparative strengths of two locomotives. Arrangements were made for a tug-of-war, in which an engine of each class took part. A steam locomotive formerly (for some 15 years) in use on the Baltimore and Ohio Railroad, having 16 × 24 cylinders, using steam at 140 lbs. pressure, weighing on the drivers about 35 tons, with a tender giving an additional weight of about 8 tons, was selected for one side; whereas its competitor was an electrical locomotive, recently built by the General Electric Company (New York), with 30 tons on the wheels. Its motor capacity was 250 horse-power. This locomotive was designed to operate on an overhead trolley, but as none was at hand, temporary cables connected the motors to the Exposition 500-volt circuit. A heavy wire cable, 20 feet long, served as a connection between the two engines. The electric locomotive was defeated without any difficulty, its aggressor dragging it all over the track.

The Morley Offer.—The Corporation of the Borough of Morley have opened a competition for a premium of £100 for the best scheme for lighting their new Town Hall, and for a scheme for lighting the hall and parts of the borough. In the conditions sent to intending competitors, it is distinctly stated that all the schemes may be rejected, and that they may not adopt electric light at all. In that case the competitors will lose considerably, as they have to obtain every information at their own expense; in fact, we do not think any scheme could be got up under, at the very least, an outlay of ten guineas. Then another peculiar condition comes in, where it is stipulated that the premium is to be merged into any commissions payable to the successful competitor if he is subsequently employed on the job; just what this means is difficult to imagine. The council may call in "a professional gentleman of eminence" to advise them after they get in the schemes. Why not call in the "Eminent One" at once, and for the £100 get a scheme from him. If he is competent to adjudicate on the competitors' schemes, he is surely competent to produce as good, if not a better, scheme than any of them, and most of the eminent ones would jump at the £100 readily enough, we opine. As this procedure does not seem to have struck the Morley authorities, we give them the hint gratis, and we will also give a hint to the intending competitors for nothing. Offer your services as "Professional Gentlemen of Eminence" down at Morley, they will not then expect you to compete, but you may be called in at last to receive the £100.

Electric Light in Camden Road.—The *Sun* makes public a fault in the electric lighting in Camden Road. One of the lamps, it appears, was out for three nights in succession. Another night two of the lamps were out, and others very dull.

Kingston Electric Lighting.—Several members of the Council have lately witnessed the formal opening of the electric light station. The whole of the lamps in the streets are to be completed by October 14th, when it is proposed to have a little celebration at the opening ceremony.

Electric Lamps for Policemen.—It is likely that Dundee policemen will be the next department of the protective forces provided with electric hand lamps instead of the ordinary oil lantern. An experiment was made there last week.

Gas Engines and the Electric Light.—A controversy on this subject is being carried on in the columns of the *Edinburgh Evening Despatch*, Prof. Kennedy's report regarding the electric lighting of the town being the main subject of criticism.

Hanley Electric Lighting.—The electric lighting operations are now being pushed forward very rapidly. The footpaths and crossings in many of the central streets have been taken up, and mains laid. The positions of the transformer chambers have been agreed upon, and the localities have been selected for the arc lamps.

Towing Canal Boats by Electricity.—In our last issue we had a note on this subject. We now cull the following further information from the *Financial Times*:—"An interesting experiment with regard to a new use of electricity as a motive power is about to be made in America. A short time ago the New York State Legislature appropriated $10,000 for experiments in the application of electricity for towing on the canals of the State. The Superintendent of Public Works has now given permission to the Westinghouse Electrical and Manufacturing Company to inaugurate and conduct experiments on electric towing on the Rochester level at Pittsford, and the tests will shortly begin. Trolley wires will be strung over the middle of the canal, and the power conveyed to the motor through transmission wires so arranged as to allow free lateral movement of the boats. The result of this experiment will be carefully noted on this side. There can be no doubt that the mechanical difficulties in the way can be overcome, but the question of expense is not so easily settled. A canal barge motor must, above all things, be a cheap motor."

Government Telephony.—"A submarine cable," says Mr. F. L. Pope in the *Engineering Magazine* (American), "has recently been laid between Scotland and Ireland by the British Post Office Department, by means of which direct telephonic communication has been established between Glasgow and Belfast. No facilities are given, however, by which exchange subscribers can be connected with the line, and hence it is necessary for two persons desiring to converse to make an appointment beforehand by telegraph, and then, at whatever inconvenience, to betake themselves to the central telegraph offices in the respective towns at the particular hour agreed upon. This is a fair sample of the kind of accommodations that we would be likely to get if the telephone system in this country should be turned over to the government, which many persons have been convinced by the newspapers it would be a good thing to do." This, we would add, is a "fair sample" of how erroneous conclusions may be jumped to when proper care is not taken to ascertain complete facts. It is perfectly true that for the time being subscribers have to go to the central offices referred to to communicate with each other, but Mr. Pope is evidently unaware that the Glasgow-Belfast circuit is only a commencement of the 10,000 miles of trunk telephone lines which the Post Office is spinning over Great Britain, and which, when completed, will enable any subscriber "without going to the central office, and when sitting in his own office," to carry on communication with any other subscriber in the United Kingdom. Because a thing is not done "right off the reel," Mr. Pope concludes that it is not to be done, or intended to be done, at all.

Obituary.—We have intelligence from Malta of the death, after a short illness, of Mr. Spiers, chief electrician in the chief constructor's department in the dockyard, who was greatly respected by all who knew him. The funeral was attended by nearly every English workman in the dockyard. Deceased, who has left a widow and several children, was well known in the fleet as a skilful electrician.

Plymouth and Electric Lighting.—A provisional order is to be applied for. The present cost of the gas lighting is £3,800 per annum.

Electric Lighting in India.—The chief engineer of the Madras Railway is now engaged in the preparation of plans and estimates for lighting Arkonam station, platforms, &c., with electric light. The cost of the plant, including erection and fitting, amounts to about Rs. 18,000.

The Incandescent Light Company of Toronto.—This company, which operates the Edison three-wire system in Toronto, is installing in its station two slow-speed multipolar Edison dynamos, manufactured by the Canadian General Electric Company. These dynamos develop 200 kilowatts, each at a speed of about 150 revolutions per minute, and are coupled direct to the ends of the shaft of a 600 H.P. vertical compound engine. The station is at present equipped with 10 100-kilowatt Edison dynamos, belted to high-speed engines, and is the largest continuous current station in Canada. Current for light and power is supplied from the same underground mains. The company claims that its rates for current for lighting are the lowest charged by any company in Canada or the United States where steam-power is used. They are three-fifths of a cent for the current used in an hour by a 16-C.P. incandescent lamp, or, in other words, 12 cents for 1,000 watt-hours. To meet these prices the local gas company recently reduced its rates, to small consumers, to $1·05, net, for 1,000 cubic feet of gas.

What is Lithanode; i.e., Stone Anode?—The first patent, says a correspondent, for the material to which this term was subsequently applied, is that dated April 15th, 1885, and numbered 4,671. The final specification for this patent commences as follows:—"My invention consists in improvements in the manufacture of plates or elements to be used in voltaic batteries, and more especially in secondary batteries. It has for its object, in the first place, the production of plates, layers or masses, mainly composed of oxide of lead in a dense and coherent form, such plates, layers or masses, being subsequently either reduced to the condition of porous metallic lead, or converted into a highly-conductive form of peroxide of lead (which, from its hardness, and the fact of its being produced at the positive pole in electrolysis, I term lithanode.)" On September 8th, 1886, a paper on "Lithanode" was read by the inventor before Section A of the British Association, at Manchester. The method of manufacture which had been patented as above was referred to in this paper. The second patent relating to lithanode is dated December 17th, 1886, and is numbered 16,608. The final specification commences as follows:—"My invention relates to the manufacture of peroxide of lead in dense, yet porous self-supporting masses (or what is known as 'lithanode') for use in voltaic batteries and for other purposes." If the definition thus given by the inventor of the material and of the term lithanode be accepted, it is evident that any peroxide of lead, manufactured by *any* process, may properly be termed *lithanode*, provided it be in the form of dense, porous, coherent, and self-supporting masses. It is further to be observed that the second process is not merely an improvement upon the first, but is distinct from and independent of it. And the third process which has been patented is not merely an improvement upon the first or second, or upon the two conjointly, but is a distinct and separate process. Consequently there are three patents for three separate processes of manufacturing the same article defined as above, viz., peroxide of lead in dense yet porous, coherent, self-supporting masses or *lithanode*. In a paper read by the inventor before the Institute of Electrical Engineers, in March, 1887, "solid peroxide" (of lead) is termed "lithanode."

Radcliffe and Electric Lighting.—A committee of the Local Board has been appointed to consider the electric lighting question.

Halifax Electric Lighting.—The Board of Trade have signified their approval of the Corporation's electric lighting system, under which it is proposed to expend £30,000.

Rugby Telephones.—There will probably be steps taken very shortly with the object of introducing a local telephone system.

City and South London Railway.—Lambeth churchwardens and overseers, considering that this railway has recently greatly improved as a property, have decided to revalue it for the purpose of assessment. Though "as a property" the line may have advanced, we think shareholders are not well pleased with the very gradual increases in the traffic receipts. Lately the weekly returns have even sometimes shown decreases as compared with the corresponding periods of last year. However, it is encouraging that one seldom hears of breakdowns or other accidents which used to be so frequent.

Effects of the Coal Strike.—Many contractors in the electrical trades have been seriously affected by the prolongation of the coal strike. We hear that the Portsmouth electric light works have been considerably delayed from this cause.

Accidental or Otherwise.—The following incident that occurred during the consideration of the electric light question by a municipal authority is one deserving of special notice by those who are keen advocates of municipal ownership. The Corporation of —— decided to carry out an electric light scheme. An engineer was appointed and tenders for electric light plant were asked for. Some six or seven of the principal contractors sent in estimates; these were published, and the announcement made that the work had been given to Messrs. A., whose price happened to be the lowest. It was afterwards discovered that Messrs. A. had underestimated, and they were allowed to amend. When, however, the matter had been settled, Messrs. B. wrote to the Corporation pointing out that their tender, which, by the way, was lower by some £800 than the one accepted, had not appeared in the published list. The Corporation were forced into the position of having to admit, through their engineer, that this tender had been completely overlooked. This is certainly very unsatisfactory, looking at the matter in the most indulgent manner.

Altrincham Local Board and Ratepayers.—It is both amusing and interesting to note the various attitudes of ratepayers in regard to electric lighting and its management municipally. Altrincham ratepayers assembled the other day, at the notice of the Local Board, to discuss whether or not they should purchase the gas works and the complete undertaking for £162,500. The ratepaying inhabitants naturally attended the meeting in a great crowd, considering £162,500 a sum not to be recklessly expended. The speeches by members of the board in favour of the purchase were not very courteously or quietly listened to by the body of ratepayers present, being generally greeted, as the local papers remark, with "laughter and dissent," cries of "proof," "question," &c. The chairman argued upon a narrow point when he stated that in places where electricity is most extensively used the gas consumption increases instead of decreases. He apparently considered this sufficient justification for their proceeding without any fear of electric lighting superseding gas at Altrincham. Several speeches having been delivered in the same strain as that of the chairman, the youngest member of the board commenced to roll the ball in the opposite direction, and it seems that some strong remarks were made against the public purchase of the works. These speeches appear to have been unpalatable to the chairman, who calls them "nonsense," which word the whole body compel him to withdraw. The vote is next taken, not a single ratepayer voting in favour, but a resolute host of them voting against the proposal of the Local Board. We should not be surprised to hear directly that electric lighting is to be taken up in earnest.

Hastings Electric Lighting.—The Board of Guardians new offices are to be lighted by electricity.

Yeadon and Electric Lighting.—The ratepayers in a body have expressed approval of an electric lighting scheme.

The Metric System in the United States.—As an indication of the growing favour of the metric weights and measures in the United States, it is interesting to note that at a meeting of the Board of Managers of Engineering Societies, recently held in Chicago, it was resolved that illustrations to be drawn to scale should bear the metric scales. Even the sporting papers of that country have adopted the kilometre, and we find therein exciting headings such as the following: "Zimmy wins the 10 Kilometre Championship."

Electric Lamps on the Underground Railway.—Very shortly a marked improvement will be effected on the District (underground) Railway, by means of which passengers, for the small consideration of one penny, will be able, upon the "penny in the slot principle," to have the use of an electric reading lamp for half-an-hour. Should curious and mischievous persons meddle with the apparatus, a warning reaches the guard's compartment. From what we learn, it seems that the wiring of the carriages is now nearly completed, about 2,500 lamps in all being required. Each lamp will be of 20 C.P., and there will be four in every compartment. It is expected that the innovation will be commenced some time in November. Undoubtedly the improvement will be very convenient to some passengers, but it remains to be seen whether the project will pay for itself.

Electric Light Fires in the United States.—According to Mr. F. L. Pope's statement in the *Engineering Magazine*, the returns for one year from the fire departments of 60 different cities in the United States, selected from among those having more than 20,000 inhabitants, show that the fires attributed to electricity constitute 1·19 per cent. of the aggregate number, and 1·23 per cent. of the aggregate losses. New York city heads the list with 59 fires, followed by Boston with 26. The generator capacity of the electric light and power plants now running in these cities, including central stations, isolated plants and street railways, amounts to more than 200,000,000 watts, which is equivalent to nearly 4,000,000 16-candle-power incandescent lamps, or 285,000 horse-power.

Commencement of the Derby Electricity Supply.—The Mayor of Derby celebrated on Tuesday the switching on of the electric light by a banquet, at which many local and other celebrities were present. The system which was selected by the Corporation has been completed in the quietest manner, and the turning on of the street and private lamps was a distinct success. We shall have more to say concerning the details very shortly; at present it is sufficient to say that a cursory examination has convinced us that sound engineering is characteristic of the work already done. The central station, which seems in a favourable situation as regards water and the ease with which extensions can be made, is designed for the supply of current for street and private lighting. The street arc lamps are run from special arc light machines by Messrs. Siemens Bros., the details of which will justify special treatment at a future date. High tension alternating machines by the same firm are used for private lighting. These machines are coupled direct to Browett and Lindley engines, three of which are to be of 100 H.P., and six of 50 H.P. The mains have been laid on a somewhat novel system, designed by the consulting engineers, Messrs. Bramwell & Harris. It is known, for some reason by many, as the ring system. To give a rough idea, it is only necessary to say that a primary current is received at the various substations; and the so-called ring main is the distributing return connected to the secondaries of the transformers. The arrangement is such that if more current is required in any particular part of the area of supply than another, there is no difficulty in meeting the increased demand, while the lightly loaded district is worked economically at the same time. The method, however, will be better understood from drawings which we hope to publish, along with other details of the station.

Lambeth and Electric Lighting.—The electric light was classed as "unnecessary and extravagant" by Lambeth ratepayers, in a resolution passed by them at a meeting held a few days ago.

Opening Canal Lock-Gates by Electricity.—The plans of Mr. T. Munro, C.E., for opening and closing the lock-gates of canals by electric motors were recently tried upon the Beauharnois Canal on the St. Lawrence River, about 30 miles above the City of Montreal, Canada. By this system each gate is operated by a steel beam, one end of which is hooked to the top of the gate about midway between the heel and mitre posts. The other end projects over the banks of the canal, and is provided with a rack in which works the pinion of a train of gear wheels. This gearing is driven by an electric motor, and serves to reduce its speed. When the motors run in one direction, the beams push against the gates and thus close them; when they run in the opposite direction, the beams pull the gates open. The experiment was entirely successful in demonstrating the advantages of electric power, though made with apparatus that was not adapted for the purpose. The gates were easily operated by the motors, being opened or closed in about one minute, an operation which takes four men at least three times as long to accomplish by hand. As a result of the trial, this system, with some modifications, has been adopted by the Canadian Government for the new canal at Sault Ste. Marie, between Lake Superior and Lake Huron, and it will probably be adopted for the other canals now being constructed in Canada. The water-power of the canal itself will be utilised for driving the dynamos, and the electric power will be used not only for operating the lock gates, but also for opening and closing the sluices in the locks.

NEW COMPANIES REGISTERED.

Electro Protector Syndicate, Limited (39,589).—This company was registered on the 16th ult. with a capital of £10,000 in £1 shares; to adopt an agreement made on the 9th inst., between Robert Jewell and C. O. Greenwell, for the sale to, and purchase by, the company of certain inventions, to adopt patents and the like, and to carry on the business of electricians, mechanical engineers, suppliers of electricity, and manufacturers of, and dealers in, mechanical and electrical appliances for registering receipts for moneys; also to carry on the undertakings of hotel, restaurant and lodging-house keepers. The subscribers (with one share each) are: C. O. Greenwell, 63, Elizabeth Street, S.W., gentleman; E. G. Saunders, Mithwater House, Barnes, S.W., gentleman; C. E. Masterman, 6, Thorney Hedge Road, Gunnersbury, engineer; A. H. Portch, 38, Scylla Road, S.E., clerk; T. E. Smith, 13, Clifton Crescent, Sutton, Surrey, secretary; A. W. Letts, 59-60, Old Broad Street Avenue, E.C., secretary; R. R. Garratt, 59-60, Old Broad Street Avenue, E.C., agent. The regulations of Table "A" mainly apply. The first directors are T. Beard, A. H. Macnaghten, E. S. Claremont, and H. E. Saunders. Qualification, £50; remuneration, £50 per annum each. Registered by Jacobs & Co., 16, St. Helen's Place, E.C.

Omnibus and Tramcar Electric Lighting Company, Limited (39,656).—This company was registered on the 28th ult., with a capital of £60,000, in £5 shares, to purchase all or any part of the shares, works, undertakings, business, property and liabilities in the Universal Electric Lighting Company; to generate, produce, store, accumulate and distribute electricity, electromotive force, or other similar agency for the purpose of lighting omnibuses, tramcars, cabs and other vehicles, public or private buildings, manufactories, mines, ships, lighthouses, railways; and to carry on the business of electricians, mechanical engineers, manufacturers of and dealers in electricity, motive power, light electrical apparatus, and appliances of all kinds. The subscribers (with 1 share each) are:—A. W. Stormont, 6, Cambrian Road, Richmond, gentleman; A. L. B. Kerr, 5, Queen's Club Terrace, Kensington, gentleman; W. J. Griffiths, 43, Finsbury Square, E.C., clerk; J. F. Rogers, 108, Penton Place. S.W., clerk; J. A. Lloyd, 54, Florence Road, N., gentleman; H. H. Clayson, 27, Borthwick Road, E., clerk; R. Wolfenden,

11, Great George Street, S.W., solicitor. Until otherwise determined, the above gentlemen are to be considered as the first directors of the company. Qualification, £100 at the least. Remuneration, £1,000 per annum, divisible. Registered by Limbray, Higgs & Wo'fenden, 43, Finsbury Square, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Exchange Telegraph Company, Limited.—The annual return of this company was filed on the 22nd ult. It shows that out of a nominal capital of £246,250, in 8,125 "A" and 16,500 "B" shares, all of £10 each, that the whole of the former, and 16,200 of the latter class have been taken up. Sums of £9 on 6,000 "A," and £1 on 2,125 "A" shares have been called, and the total amount of calls received is £56,023. The amounts agreed to be considered as paid are £17,000 on 2,125 "A," and £162,000 on 16,200 "B" shares. A sum of £102 is yet outstanding.

Eastern and South-African Telegraph Company, Limited.—The whole of the nominal capital of this company, viz., £600,000, has been taken up and paid in full.

Manchester Edison-Swan Company, Limited.—This company has lately filed its annual return, and from this it seems that out of a nominal capital of £550,000, in 50,000 "A" shares of £9 each, and 10,000 "B" shares of £10 each, as many as 20,000 "A" and 10,000 "B" shares have been taken up; £1 per share has been called on the former, and the full amount on the latter. The total result of these payments reaches £120,000.

Marshall, Sons & Co., Limited.—This company has filed its annual return up to May 12th, 1893. Out of a nominal capital of £400,000, in 10,000 shares of £20 each, and £200,000 consolidated stock, 2,000 shares have been taken up, with £1 called on each. The total amount of calls received is £2,000, and the amount of stock held up to the date of the return equals £200,000.

Municipal Electric Light and Power Corporation, Limited.—The annual return of this company for the last year has been filed quite recently. It appears that the nominal capital was £25,000 in 2,490 ordinary shares of £10 each and 100 founders' shares of £1 each; and that 37 ordinary and 30 founders' shares have been taken up; the full amount called and £400 paid. The return for 1893 indicates no alteration in the above figures.

Globe Telegraph and Trust Company, Limited.—The annual return of this company has been lately filed at Somerset House, and shows that out of a nominal capital of £5,000,000, in 250,000 preference and 250,000 ordinary shares of £10 each, 180,042 of the former and 180,227 of the latter class have been taken up. A sum of £3,602,690 has been received in payment of the calls made.

Oriental Telephone and Electric Company, Limited.—The annual return of this company, made up to the 6th of last month, shows that out of a nominal capital of £300,000, in 225,000 ordinary and 75,000 vendors' shares, all of £1 each, 220,000 ordinary with 11s. paid, 3,746 ordinary with £1 paid, and 75,000 vendors' with £1 paid, have been taken up. There has been £121,000 paid; £75,000 has been considered as paid on 75,000 vendors' and £3,746 on 3,746 ordinary shares.

Penzance Electricity Supply Company, Limited.—This company was dissolved under clause 7 of the Companies' Act, 1880 (43 Vict. c. 19) by notice in the *London Gazette*, dated August 15th, 1893.

Pacific Telegraph Company, Limited.—The original capital of this concern was £2,000,000, in £10 shares; and from the last return filed at Somerset House, it appears that only 18 shares have been taken up, with the full amount called on each. A sum of £130 has been remitted, which leaves £50 still outstanding.

Waterhouse Electrical Manufacturing Company, Limited.—This company has lately filed its annual return, from which it seems that out of the nominal capital of £20,000 in £10 shares, 1,000 of which are vendors', and the remaining 1,000 ordinary, 272 of the latter class have been taken up, with £6 13s. 4d. called on each. An amount of £2,563 6s. 8d. has been paid, and £10,000 has been considered as paid on the 1,000 vendors' shares. There is £156 13s. 4d. in arrear.

Electric and General Investment Company, Limited.—This company has lately filed its annual return, which shows that out of a nominal capital of £200,000, in £5 shares, whereof 39,900 are ordinary, and the remaining 100 founders', 20,000 ordinary and the whole of the founders' shares have been taken up. A sum of £1 has been paid on each of the first named class of shares, and the full amount on the latter. Altogether, the payments have realised £20,500.

Electrical Power Storage Company, Limited.—This company filed its annual return a few weeks ago. From this document it appears that the nominal capital was £100,500, in 100 founders' and 20,000 ordinary of £5 each; and that 70 of the former shares and 18,657 of the latter have been adopted. The full amount has been called on the founders' and £3 on each of 3,537 ordinary shares, and a sum of £9,221 18s. 8d. has been received. There has been £75,600 agreed to be considered as paid on 15,120 shares; £1,369 1s. 3d. is yet unpaid, and £400 has been paid on 200 ordinary shares forfeited.

South of England House-to-House Electricity Company, Limited.—According to a notice filed at Somerset House a few weeks ago, it appears that the registered office of this company is now situated at Richmond Road, Earl's Court, S.W.—adjoining the District Railway Station, West Brompton.

Northern House-to-House Electricity Company, Limited.—The registered office of this company is situated at the same place as that of the South of England House-to-House Electricity Company, viz., Richmond Road, Earl's Court, S.W.

Laing, Wharton & Down Construction Syndicate, Limited.—This company has filed its annual return for the past financial year, and from this it appears that £100,000, in £10 shares, was the original capital. As many as 4,516 shares have been taken up; £10 has been called on each of 2,660, £2 10s. on 397, and £5 on 329. The total amount of calls received equals £29,237 10s., and £11,300 has been agreed to be considered as paid.

River Plate Electricity Company, Limited.—The annual return of this company was filed not long ago; out of a nominal capital of £500,000, in 49,900 £10 ordinary, and 1,000 £1 founders' shares, 13,557 ordinary and 892 founders have been adopted. The full amount has been called on the founders', and on 11,157 of the ordinary shares £110,892 has been received; £24,000 has been agreed to be considered as paid, and £1,570 is still outstanding.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—October 25th. Wanted for supplying boiler, engine, dynamo, and other electrical plant for the Northern Co-operative Company's central premises. Specifications to be obtained from the secretary, 54, Loch Street, Aberdeen.

Cardiff.—October 16th. The Corporation invite tenders for the manufacture and delivery of electric light cables; also for drawing-in certain portions of the same, and making all necessary joints. Particulars may be obtained on application to Mr. W. Harpur, Borough Engineer, Town Hall, Cardiff; or Mr. W. H. Massey, of 25, Queen Anne's Gate, Westminster.

Manchester.—17th inst.—Tenders for supplying and fixing electrical plant. Full particulars will be found among our advertisements.

CLOSED.

Melbourne.—The tenders of the Otis Elevator Company for £335 for the supply of pumping machinery in connection with the electric lighting scheme, and that of Messrs. A. Murray & Co. for £19 19s. for poles, were recently accepted. These two contracts are the last in connection with the scheme, on which a sum of £45,000 will have been expended when the system shall have been completed. This, it is anticipated, will be the case in November or December.

BUSINESS NOTICES, &c.

The Universal Electrical Directory (J. A. Berly's), now under the direct supervision of the proprietors, H. Alabaster, Gatehouse & Co., is in active preparation for the 1894 edition (13th year). This is a directory of the electrical trades embracing the whole Universe, and having no superfluous matter irrelevant to a directory it can be sent everywhere, carriage paid, for 4s. It is indispensable to all having business transactions in the electrical world, and once used cannot be done without. Advertise in it! Order it! It will prove the best outlay ever made.

New Electric Light Ladder.—Electric lighting demands light and useful ladders of an easily portable character, and Messrs. J. H. Heathman & Co., of 2, Endell Street, W.C., have been devoting attention to the requirements of the electrical world. They have just sent to the Blackpool Corporation Electric Lighting Department a wheeled extension ladder, as here illustrated. It is capable of

being used by a youth, and extends from 10 feet 6 inches up to 27 feet 6 inches, but can be securely locked at any intermediate height. It is mounted upon two wheels, and has a spacious box for tools and carbons. The ladder is pivoted, so that it is readily detachable, or can be swung to pass under a doorway 6 feet 6 inches high. The same firm are now making two for the Derby Corporation Electrical Department to the order of Messrs. Siemens Brothers, and they have also others on order.

Gas v. Electric Light in Killarney.—The question of the public lighting of the town of Killarney is now engaging attention. Not long since the Gas Company and the Electric Light Company tendered for the lighting of the town; the former at £92 10s. and the latter at £50, and at a meeting of the Killarney Town Commissioners the contract was given to the Gas Company, notwithstanding the difference between the tenders. The Electric Light Company allege informality in the declaration of the contract and served a notice on the Town Clerk and on the Solicitor for the Town Commission Board cautioning them not to perfect the contract for the gas. According to the contract 37 lamps were to be used for public lighting, four of which were to be kept burning all night.

Electric Light at Dover.—In anticipation of the successful floating of a local company for the supply of the electric light in Dover, definite steps have been taken for the acquisition of a site for a central station. The grounds of the Dover Lawn Tennis Club have been selected. The negotiations between the Town Council and the Brush Electric Lighting Company have now been practically completed, and as soon as the local company has been formed the new form of illumination will be introduced. The Corporation are entering into agreements for the lighting of the sea front and main thoroughfares by electricity, and many of the leading tradesmen have already signified their intention of having the light laid on at their premises.

Glasgow Tramways and Electricity.—The Tramways Committee have agreed to accept tenders amounting to over £5,000 for the construction of a tramway depôt at Springburn. They have further resolved to ask Mr. Arnot, the city electrical engineer, to submit a statement showing the price at which the electrical energy could be supplied to batteries for the electric haulage of the cars, and also, the cost of laying down and superintending the dynamos and other plant required for charging the batteries from five of the car depôts now being erected by the Corporation.

Lists, Catalogues, &c.—A new and revised list of iron and steel tubes has been published by Messrs. John Spencer, of Wednesbury. Boilers, gas, steam, and water tubes and fittings, are priced in detail, as are also a variety of other descriptions of tubes and accessories. Artesian well boring tubes, hot water tubes, driving points, and many similar articles have space devoted to them. On page 13, we observe particulars of wire and cable tubes for electrical purposes as supplied to the City of London Electric Lighting Company, Limited. Information regarding telegraph poles and the usual kindred fittings, are followed by a number of pages dealing with brass and steam fittings, boiler mountings, several types of pumps, while at the end of the pamphlet are tabulated the Whitworth's standard tube threads, and the weights of round iron per foot. The list is a very handy one and contains much information considering its dimensions.

Messrs. Nalder Brothers & Co. have sent us a copy of their latest catalogue and price list of electrical testing, mathematical, optical, and other scientific instruments as manufactured by them at Clerkenwell. Printed throughout in a bluish ink and bound in stiff brown covers, the book, which measures about 9 inches by 6 inches, is a very neat piece of handywork. The blocks have been most carefully engraved, and printed in an exceptionally clean manner, and much credit is done both Messrs. Nalder Brothers and the firm who have so well executed their work. The whole has been tastefully set out, and what is a great improvement is the classing of illustrations only on right hand pages and the description on the left page, facing the illustrations. This is done throughout the greater part of the book. An extensive system of coding has been adopted, and the straightforward manner in which the necessary details have been placed ready for easy reference might well be imitated by other catalogue compilers. Batteries, standard cells, galvanometers, voltmeters, resistance coils, and instruments of this class are, of course, the chief feature of the catalogue. Approaching the end of the book we find particulars and illustrations of the apparatus and instruments described in Prof. Ayrton's book on "Practical Electricity." We have much pleasure in recommending the catalogue to the attention of the trade. As a catalogue it is an excellent piece of work, while the firm's customers will, after practical experience, testify to its serviceableness.

Messrs. J. Hopkinson & Co., of Huddersfield, have sent us a very nice artistic wall card, 2′ 6″ × 1′ 10″, showing in colours one of Hopkinson's patent slide valves. They have also sent us a number of catalogues and other pamphlets concerning the valves.

Mr. Kneed Sando's Failure.—Under the failure of this debtor, accounts have been filed at the London Bankruptcy Court showing total liabilities £32,944, of which £9,097 9s. 3d. are expected to rank against assets valued at £7,991 19s. 5d. In December, 1890, the debtor states he began trading as a manufacturer of electrical appliances, which business he carried on at Appold Street, E.C., and subsequently at Richmond, Surrey. The debtor further states that in December, 1891, a company was registered under the style of the Central Electrical Company, Limited, with the object of acquiring and carrying on the business last mentioned, the company, however, did not go to allotment, and the debtor states he continued the business for his own account until February, 1892, when, having to go abroad on other matters, it was closed, at a loss to him, as he estimates, of £3,000. The debtor attributes his present insolvency to losses in promoting the "General Phosphate Corporation," and loss of business through having to go to Canada in 1892 to assist this company. The claims of the unsecured creditors are said to be mainly in connection with the electrical business before mentioned. The debtor has intimated his intention of submitting a proposal to his creditors, the particulars of which, however, have not yet been lodged. The creditors meet on the 27th instant, by adjournment, and the public examination of the debtor is appointed for 31st instant.

Saunders & Co. v. Insole.—At the Cardiff County Court last week before his Honour Judge Owen, Messrs. J. B. Saunders and Co., electrical engineers, brought an action against Mr. J. H. Insole, of Ely Court, Cardiff, to recover £23 2s. 9d. The claim was £17 for laying gas pipes from the main to within Mr. Insole's premises to the gas engine, which was laid down by the plaintiffs for the purpose of generating electric light. A contract was put in in which the plaintiffs undertook to supply all necessary plant for giving Mr. Insole 75 lights of 16 candle-power for £950. This sum had been paid, together with other moneys for extras admitted by Mr. Insole. On the claim £4 was paid into court for some of those extras which had been overlooked. The remaining part of the claim was £4 for a voltmeter and £16 for the gas mains. His Honour was of opinion that the mains and the meter were necessary for a complete installation, and were covered by the contract. He gave judgment for plaintiffs for the amount paid into court, and ordered them to pay defendant's costs from the time the moneys had been paid in.

Electric Lighting at Dundee.—The works of Messrs. Wm. Fergusson & Sons, at North Tay Street, Dundee, have lately been lighted throughout by electricity, a complete installation being fitted up by Messrs. Lowdon Bros., who worked to specifications prepared by Messrs. Urquhart & Small. The light was turned on for the first time on 4th inst. The dynamo (Elwell-Parker), which runs at 320 revolutions per minute and is capable of lighting 700 16-C.P. lamps, has coupled to it a 70 I.H.P. engine manufactured by Messrs. G. E. Belliss & Co. The number of lamps at present fitted is about 630. The factory ground floor has 350, first floor about 100, and on the attic floor about 180. A 16-C.P. lamp is suspended over each loom at a distance of about two feet.

There is a proposal to light by electricity the dials of the Old Steeple. The necessary apparatus is estimated to cost £30. Mr. Lowdon has submitted a short report on the subject.

W. Mackie.—In our last issue we stated that the St. Olave's Board of Works Offices contemplated introducing the electric light into the buildings. We now learn that Mr. W. Mackie, of Turnmill Street, has secured the contract for a complete plant. He has also in hand the contract for lighting the new St. Olave's Grammar School (designed by Mr. E. W. Mountford), which is being erected on part of the site of the old school in Tooley Street. The number of lights in the new schools will be 410.

Woodhouse & Rawson, Limited.—A general meeting of this Company is announced to be held in room 434, at 11, Queen Victoria Street, E.C., on November 8th, 1893, at four o'clock in the afternoon, pursuant to section 142 of the Companies Act, 1862, for the purposes therein mentioned, and for the purpose of passing an extraordinary resolution, directing as to the manner in which the books, accounts, and documents of the Company and of the Liquidators, shall be disposed of.

Ipswich Electricity Supply Company.—A petition for the winding up of the above Company was, on October 6th, presented to the High Court of Justice by Marcus Percy Shorrock, of 34, Waldemar Avenue, Fulham, a shareholder of the said Company. The petition is directed to be heard before the Court sitting at the Royal Courts of Justice, Strand, London, on October 25th, 1893.

Sunderland Electric Lighting.—The Corporation will shortly be advertising for tenders for electric lighting. There will be three contracts to let, one for cutting the roads and making culverts in which to carry the wires underground, one for metal pipes and castings, and one for store work pipes and insulators.

Postal Tubes.—From the Corruganza Manufacturing Company, Limited, we have received several specimens of cardboard postal tubes with Ransome's extractor. The articles are specially convenient and suitable for sending out price lists.

Abell's Electrical Engineering Company, Limited.—Claims on this company, which is in voluntary liquidation, have to be made to F. W. Marsh, Bank Chambers, Hardshaw Street, St. Helen's, by November 15th.

Dissolution of Partnership.—Messrs. Frank Suter and Co. having dissolved partnership, dating from 2nd inst., debts will be attended to by H. E. H. Wyman and F. W. Suter, who continue the business.

Paterson & Cooper.—This firm have been placed upon the Admiralty list for dynamos. They have been for several years on their list for general fittings, and have recently completed a large order.

Electric Lighting of the Royal Exchange.—Messrs. J. G. Statter & Co. have secured the contract for the electric lighting of the Royal Exchange.

Bolton and Electric Lighting.—The authorities are now inviting intending users of electric light to make their formal applications.

CITY NOTES.

Brazilian Submarine Telegraph Company, Limited.

The directors' report for the half-year ended June 30th, 1893, to be submitted to the 40th ordinary general meeting on 18th inst., states that the revenue for this period amounted to £106,859 18s. 2d, and the working expenses to £40,580 1s. 5d. After providing £12,880 for debenture interest and sinking funds, and £1,367 8s. 1d. for income tax, there remains a balance of £52,032 8s. 8d., and to this is added the sum of £4,000 18s. 1d. brought forward from December 31st last, making a total of £56,033 6s. 9d. A quarterly interim dividend, amounting to £19,500 has been paid, and £7,000 transferred to the reserve fund, increasing that fund to £638,675 8s. 6d. The directors now recommend the declaration of a final dividend of 3s. per share, making, with the interim dividends, a total dividend of 6 per cent. for the year, and also the payment of a bonus of 1s. per share, both free of income tax, which together will amount to £26,000, leaving a balance of £3,533 6s. 9d. to be carried forward. The dividend and bonus will be payable on the 19th inst. On July 31st last the sum of £17,700 was transferred to pay off the 177 bonds of the 1884 issue, drawn for redemption in April last. This repayment reduces the debenture debt to £93,700. The receipts for the half-year include the sum of £1,500 dividend to December 31st, 1892, on the company's shares in the African Direct Telegraph Company, Limited. The directors with much regret have to report the death, on May 7th last, of their esteemed colleague, Sir James Anderson. At the invitation of the directors, Sir John Pender, G.C.M.G., M.P., has joined the board, and accepted the chairmanship of the company. Under a contract dated June 17th, 1893, between the Portuguese Government and the Telegraph Construction and Maintenance Company, Limited, the Eastern Telegraph Company, Limited, and this company are entitled to a prolongation for 10 years of their respective privileges under existing Portuguese concessions. By arrangement with the companies concerned your company has secured a considerable interest in the cable recently laid between Lisbon and the Azores under that contract. The various sections of the company's line are in good working order. Mr. J. Denison Pender and Mr. Frederick Youle, retire at this meeting, and being eligible for re-election as directors, offer themselves accordingly. The retiring auditors, Mr. Henry Dever and Mr. John Gane desire to offer their respective firms, Messrs. Deloitte, Dever, Griffiths & Co. and Messrs. Gane, Jackson and Jefferys, for election as auditors to the company.

The A. U. Alcock Electric Light Company.

The seventh half-yearly meeting of the A. U. Alcock Electric Light and Motive Power Company, Limited, was held at the offices of the company, Russell Street, Melbourne, on August 31st, Mr. W. J. Mountain presiding.

The directors' report, which was adopted, stated that the revenue for the last six months, compared with the corresponding period of last year, showed an average increase of over £150 monthly, while the working expenses had been reduced by over £102 per month. The profit made during the last 10 months amounted to £289, which was considered to be highly satisfactory, as that period embraced the summer months, when the demand for current was lightest.

The Chairman, in referring to the company's position and the depression, said that it was highly satisfactory to note that the revenue had improved steadily, and had doubled since 1889, as it now amounted to £851 18s. 2d. In 1889 the profit was only £111 1s. 6d., and this year it had reached £289 3s. 2d. During the period under review the machinery was continually working throughout the 24 hours of each day, and in consequence the company's profits were nearly trebled, and the public could secure a supply of current at any hour of the day. This latter factor, together with the meter system, had done much to popularise the use of the electric light. Their customers were economising in their use of current, and as an instance he stated that the account of one large customer had only amounted to £16 16s. 2d. last March, compared with £42 15s. 8d. for the corresponding period of 1892. With an increased output the efficiency of the central station would improve as better results were obtained from the quantity of fuel consumed. The average electricity generated per month for the first quarter of this present year was 35,244 units, and the consumption of coal 169 tons; for the following quarter the output was 50,701 units average per month, and coal consumption 217 tons. Thus, although the output was increased 43 per cent., the consumption of coal only increased 28 per cent. These results, however, were only being obtained by practising strict economy and improving the efficiency of the machinery wherever possible. The demand for light had been more than was expected since July 1st, and the custom had increased to the extent of 649 16-C.P. lamps, with prospects of many more being added during the next few months.

Mr. Simon Fraser, M.L.C., and Mr. H. U. Alcock were re-elected directors.

Messrs. C. M. Holmes and W. J. Anderson were re-elected auditors

Eastern and South African Telegraph Company.—On Tuesday, November 14th, at the company's offices, Winchester House, 345 five per cent. mortgage debentures will be drawn for payment on January 1st, 1894. Notice will be given by advertisement of the numbers of the debentures drawn.

The payment by warrants on November 1st, 1893, of interest on the 4 per cent. Mauritius subsidy debentures is announced in respect of instalments paid to October 31st, 1893. The transfer books will be closed from October 27th to November 1st, both days inclusive.

The Direct United States Cable Company, Limited.—The board have resolved upon the payment of an interim dividend of 3s. 6d. per share, free of income tax, being at the rate of 3½ per cent. per annum for the quarter ending September 30th, 1893, such dividend to be payable on and after the 24th inst.

Eastern Telegraph Company.—The payment by warrants on November 1st of interest is announced for the half-year ending October 31st on the 4 per cent. mortgage debenture stock. The transfer books will be closed from October 27th to November 1st, both days inclusive.

Submarine Cables Trust.—On and after the 16th inst. the sum of £1 15s., on account of the coupon due October 15th, 1893, will be paid by Messrs. Glyn, Mills & Co., of 67, Lombard Street, between the hours of 10 a.m. and 2 p.m. The coupons should be left with the bankers for examination four clear days before payment.

Stock Exchange Notices.—The Stock Exchange Committee have ordered the undermentioned security to be quoted in the Official List:—Commercial Cable Company—Further issue of $2,284,000 capital stock.

Richmond (Surrey) Electric Light and Power Company, Limited.—We understand that this Company went to allotment on the 10th instant.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending October 8th, 1893, amounted to £813; week ending October 9th, 1892, £859; decrease £46; total receipts for half-year, 1893, £11,262; corresponding period, 1892, £10,853; increase £409.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending October 6th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,485.

The Great Northern Telegraph Company. The traffic receipts in September, 1893, were £23,600; January 1st to September 30th, 1893, £203,600; corresponding months, 1892, £199,600; corresponding months, 1891, £213,400.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.‡	Closing Quotation, October 4th.	Closing Quotation October 11th.	Business done during week ended October 11th, 1893. Highest.	Lowest.
184,500£	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	99 —102	...	...
1,134,640£	Anglo-American Telegraph, Limited	Stock	50 — 51	49¼— 50½	50	...
2,932,680£	Do. do. 6 p. c. Preferred	Stock	92 — 93	92 — 93	93¼	92¼
2,932,680£	Do. do. Deferred	Stock	9¼— 9⅝	9 — 9⅛	9⅝	9¼
130,000	Brazilian Submarine Telegraph, Limited	10	11⅛— 12	11⅜— 12¼	12	11⅛
18,700£	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000£	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	107 —111	107 —111	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅞ — 3	2⅞ — 3	3	...
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛ — 2⅜	2⅛ — 2⅜	2⅛	2 3/16
125,000£	Do. do. 4½ per cent. Debenture Stock	Stock	107 —109	107 —109	108	...
20,510	Charing Cross & Strand Electricity Supply Nos. 1 to 6, 215 to 718, and 10,001 to 30,000	5	4⅞— 5¼	4⅞— 5¼	...	...
44,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	2 — 3	2 — 3	...	...
630,000£	City and South London Railway	Stock	30 — 35	30 — 35	...	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	11¼— 11⅜	11¼— 11⅜	...	...
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	12⅜— 13¼	12⅜— 13¼	13⅛	12 1/16
$7,716,000	Commercial Cable, Capital Stock	$100	135 —140	135 —140	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	10/-	1/16— 1/8	1/16— 1/8	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	3½ — 4½	3½ — 4½	...	...
50,000£	Do. do. 5 p. c. 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	96 —101 xd	96 —101	...	...
16,000	Cuba Telegraph, Limited	10	11 — 12	11 — 12	11⅜	...
6,000	Do. do. 10 p. c. Preference	10	18 — 19	18 — 19	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½— 3½	2½— 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	8½ — 9½	8½ — 9½	9¼	...
60,710	Direct United States Cable, Limited, 1877	20	11⅜ — 11⅝	11⅜ — 12	12	11 1/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	15 — 15½	15 — 15½	15½	15 1/16
70,000	Do. 6 p. c. Preference	10	16 — 16½	16 — 16½	16½	16½
105,900£	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	106 —109	107 —110	...	...
1,294,100£	Do. 4 p. c. Mortgage Debenture Stock	Stock	112 —115	113 —116	115⅜	114
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15¼— 15⅜	15¼ — 15⅜	15⅜	15¼
62,700£	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	102 —105	...	...
222,800£	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	102⅜	...
320,000£	Do. 4 p. c. Debenture Stock	Stock	111 —114	112 —115	113½	113
108,700£	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104	101 —104	103½	...
146,800£	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104	101 —104	...	...
300,000£	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	101 —104	101 —104	102½	...
200,000£	Do. 4 p. c. Reg. Mt. Debs. (Mauritius Subsidy) 1 to 8,000	25	103 —106 %	104 —107 %	105⅜	105¼
49,900	Electric Construction, Limited, Nos. 101 to 45,100	10	1½ — 2	1⅝ — 2½	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	⅛ — ¼	⅛ — ¼	...	...
91,195	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	⅛ — ⅜	⅛ — ⅜	⅛	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	⅛ — ⅜	⅛ — ⅜	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	½ — 1½	¾ — 1½	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅜ — 9⅝	9⅜ — 9⅝	9⅞	9 11/16
180,042	Do. do. 6 p. c. Preference	10	15½— 15⅝	15½— 15⅝	15⅝	15½
150,000	Great Northern Tel. Company of Copenhagen	10	20 — 20½	20 — 20½	...	...
200,000£	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	103 —106	103 —106	104⅜	...
12,134£	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½— 5½	4½— 5½	...	...
9,600£	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6 — 7	6 — 7	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21½— 22½	21½— 22½	22⅛	21⅞
200,000£	Do. do. 4½ p. c., Deb., 1896	100	101 —103	101 —103	...	...
17,000	Indo-European Telegraph, Limited	25	39 — 42	39 — 42	40¾	40¼
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	1 — 2	1 — 2	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4⅛— 4½	4⅛— 4½	4 7/16	4 7/16
15,000	Do. do. fully paid	5	6 — 6½	6 — 6½	6⅛	5⅞
37,500	Liverpool Overhead Railway Ordinary, fully paid	10	5½— 5⅝	5½— 5⅝	8¼	4⅜
6,295	Do. do. Pref., £4 paid	10	4 1/16— 4 3/16	4 1/16— 4 3/16	4⅛	...
37,548	London Platino-Brazilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000£	Do. do. do. 6 p. c. Debentures	100	105 —108	105 —108	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6⅜— 7¼	6⅜— 7¼	...	...
50,000£	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	104 —107	104 —107	106½	105¼
15,000	Monte Video Telephone Co., Ord., Nos. 1 to 15,000 fully paid ...	5	1½— 2½	1½— 2½	...	...
28,000	Do. do. 6 p. c. Pref., Nos. 1 to 28,000 fully paid	5	3 — 4	3 — 4	...	...
458,867	National Telephone, Limited, Nos. 1. to 438,984	5	4½ — 4⅝	4⅝ — 4⅞	4 13/32	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	14 — 15	14 — 15	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13½— 14½	13½— 14½	14⅛	13⅞
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	5⅛— 5⅜	5⅛— 5⅜	5 5/16	5⅛
726,477£	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	112 —114	112 —114	113¼	113¼
48,800	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,452	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 — 6	5 — 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	⅛— ⅜	3/16— 5/16	¼	...
100,000£	Pacific and European Tel., Ltd., 4 p. c. Guar. Debs., Nos. 1 to 1,000	100	101 —104	101 —104	...	...
11,802	Reuter's Limited	8	4½— 5⅛	5 — 6	...	...
19,980	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	6¼— 6⅜	6¼— 6⅜	...	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8½	8 — 8½	8¼	8⅛
3,381	Submarine Cables Trust	Cert.	116 —121	116 —121	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	2 — 2½	2 — 2½	...	...
37,350	Telegraph Construction and Maintenance, Limited	12	32 — 34	31 — 33	32½	...
150,000£	Do do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	103	...
58,000	United River Plate Telephone, Limited	5	2 — 2½	2 — 2½	...	...
146,370£	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 100	90 —100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	5½— 6½	5½— 6½	...	...
260,900£	Do. do. do. 5 p. c. Debentures	100	98 —101	98 —101	...	...
30,000	West Coast of America Telegraph, Limited	10	2 — 3	2 — 3	...	...
150,000£	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	98 —102	98 —102	...	...
64,242	Western and Brazilian Telegraph, Limited	15	6½— 7	6½— 7	7	6 15/16
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5½— 6½	5½— 6½	6	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1 — 1½	1½ — 1⅝	1½	1⅜
178,200£	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	103 —106	...	...
222,700£	Do. 5 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	..
88,321	West India and Panama Telegraph, Limited	10	1⅛— 1⅜	1⅛— 1⅜	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — 10½	10 — 10½	10 5/16	10
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	9 —10	9 — 10	...	...
80,000£	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	106 —109	106 —109	...	...
$1,214,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	115 —120	115 —120	...	...
169,000£	Do. do. 6 p. c. Sterling Bonds	100	101 —104	102 —105	104½	104
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5 — 5½	5 — 5½	5¼	5 1/16

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5—5¼.—Brush Company, 4½ per cent. Debenture Stock, issued at 1 per cent. premium, 100—103.—Electric Construction Corporation 6 per cent. Debentures, 95—98.—Electric and General Investment, shares of £5 (£1 paid), 1⅝—2⅛.—Founders' shares, 200—225.—Electricity Supply Corporation, Ordinary of £5, 5—5½.—House to House Company (£5 paid) 1¾—2¼.—Do. 7 per cent. Preference of £5, 4—5¼.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5¾—6¼, 1st Preference Cumulative 6 per cent., £5 (fully paid 5—6¼.—Manchester, Edison and Swan Company £9 (£1 paid), ¼—½.—Queen Anne's Mansions Lighting and Heating 6 per cent. £100 Debentures, 102—103.

Bank rate of discount, 3 per cent. (October 5th, 1893.

THE PRACTICAL MEASUREMENT OF ALTERNATING CURRENTS.

Lecture III.

The third of this series of lectures was devoted to considerations of the measurement of alternating current power. Dr. Fleming said that when a current flows through a conductor it dissipates energy, and the rate at which this energy is dissipated was what is meant by the *power* taken up in that circuit. For a constant current, the product of volts and ampères gave the power in watts. In the case of an alternating current, however, in which the current strength is varying from instant to instant, according to a periodic law, and where also the P.D. at the ends of the circuit varied periodically, it was not always possible to obtain the value of the power by taking the product of the $\sqrt{\text{mean-square}}$ ampères, and $\sqrt{\text{mean-square}}$ volts. What was really required in such a case was the mean-value of the power, which implied that at every instant we must measure the true value of the current strength and the P.D.; this product would give the instantaneous value of the power at every instant; and if the whole period were imagined to be divided into a large number of equidistant intervals of time, and those products taken at every such instant, then the mean value of these products, taken throughout the period, would give us a close approximation to the mean value of the power being absorbed in the circuit.

In dealing with the power taken up in alternating current circuits there were two cases to be considered. The first, where the circuit is non-inductive; here the "impedance" is the same as its resistance, numerically speaking. For such circuits the alternating current was in step as regards phase, with the alternating P.Ds. between the ends. When this is the case, the power taken up in the circuit can very easily be measured. If the $\sqrt{\text{mean-square}}$ value of the alternating current were measured by means of any of the ordinary dynamometers, and if, by means of any of the electrostatic or thermal voltmeters the $\sqrt{\text{mean-square}}$ P.D. between the ends of the circuit were ascertained, then, multiplying these two mean-square values together, we find the mean value of the power taken up in the circuit; and we arrive at the same result as if we had been able to measure separately the instantaneous values of the current and P.D. at numerous equidistant intervals throughout the phase, and had taken the mean value of their products. As an instance of this, Dr. Fleming pointed out that an incandescent lamp may be treated as a practical non-inductive circuit. If the alternating current flowing through such a circuit were measured, say, by a Siemens's dynamometer, and the P.D. at the terminals of the lamps by, say, a Cardew voltmeter, then multiplying together the readings of these two instruments gives the mean value of the power, measured in watts, taken up in the lamps. In any circuit which is non-inductive there is, therefore, no difficulty, by means of instruments of the proper kind, in determining the real mean power taken up in the circuit.

The difficulties appeared in circuits such as transformers, which, when not fully loaded, are known to be inductive. If, in such a case, we can determine the instantaneous values of the current and P.D., then, proceeding as above described, we can determine the mean value of the power taken up in the circuit. If, however, it is not convenient to do this, we cannot proceed to measure the $\sqrt{\text{mean-square}}$ values of the current and E.M.F., and then multiply them together. Such a proceeding would lead to a considerable over-estimate of the real power taken up in the circuit. The lecturer gave a graphic representation of the two cases above mentioned: (1) by drawing two simple harmonic curves in step with one another corresponding to a non-inductive circuit, the current and E.M.F. having their maxima at the same instants, the product of the square root of the mean of the squares of the separate ordinates is here equal to the mean value of the products of the corresponding ordinates. This could be shown by squaring each of the values of the ordinates in the two curves, and taking the square root of the mean of the squares; in this way could be obtained, for each curve, a number which would represent the instrumental value as given by an alternating current dynamometer or voltmeter. Multiplying together the simultaneous values of current and E.M.F., a number could be obtained which would represent the instantaneous value of the power taken up in the circuit, and the mean value of all these separate instantaneous values of the power gives the same number as that which would be arrived at by taking the products of the square roots of the mean of the squares of the instantaneous values of the current and electromotive force. This, however, does not remain true for case (2) in which the current and E.M.F. are not in the same phase. In this case the curves are displaced relatively to one another, as happens in an inductive circuit, where the periodic current always lags in phase behind the periodic E.M.F. Performing the same operations on the ordinates of these curves, as above, gives a product of the mean-square values in excess of the mean of the product of simultaneous values. In other words, if, in such a circuit, the current were measured by means of a dynamometer, and the potential difference between the ends by an alternating current voltmeter, the product of these two numbers would give a value in excess of the true mean power taken up in the circuit. It is convenient to call the product of the $\sqrt{\text{mean-square}}$ ampères and the $\sqrt{\text{mean-square}}$ volts the "*apparent watts*," and to call the true mean value of the power the "*true watts*." The ratio between the true watts and apparent watts is called the "*power-factor*" of the circuit. In the case of a transformer on open circuit, the transformer magnetic circuit being of the closed type, the power-factor is about ·7; in other words, the real power is only about three-quarters of the apparent watts. A transformer of the open magnetic type may have a power-factor as small as ·1, showing what an enormous error would be committed by taking the product of the instrumental readings as simply representing the true mean power taken up in the circuit. It remained to indicate how this true mean power can be practically measured. Passing over the merely theoretical methods, the lecturer proceeded to describe only those instruments which will give, practically, the power taken up in inductive circuits. The most practical, and by far the best instrument to use for this purpose was the electro-dynamometer. The fixed coil is to be placed in series with the circuit in which the power is being used, and the movable circuit is to consist of only a few turns of wire joined in series with a non-inductive resistance, which may be formed either of coils of wire, or incandescent lamps. This movable coil, with its added resistance, is to be placed as a shunt across the ends of the circuit in which it is required to measure the power. When the alternating E.M.F. is applied to the circuit, the fixed coil of the dynamometer (now called a "watt-meter") will be traversed by a periodic current, identical with that passing through the inductive resistance. The movable coil of the wattmeter will be traversed by a current which will be in step, as regards phase, with the P.D. between the ends of the inductive circuit. When the dynamometer thus has its two circuits traversed by two currents, the force required to hold the movable circuit in its normal position against the electro-dynamic force is, at any instant, proportional to the product of these currents. If then the currents vary from instant to instant, and if the time of vibration of the movable coil is very long compared with the periodic time of the current, the mean value of the force required to hold the movable coil in its normal position, with its axis at right angles to that of the fixed coil, will be proportional to the mean value of the products of the currents in the fixed and movable coils respectively. That is to say, to the mean power being taken up in the inductive circuit. The force required to hold the movable coil in its normal position may be furnished by the torsion of a spring; and hence we can, with such an instrument, read off the mean power being taken up in the inductive circuit, provided that the wattmeter is already standardised. The best way to standardise the wattmeter is to apply it to measure the power taken up in a known standard non-inductive circuit, and at the same time to measure the mean-square value of the current flowing through this circuit and the $\sqrt{\text{mean-square}}$ value of the P.D. between its ends. In this way the wattmeter is applied to measure the known power being taken up in a non-inductive circuit, and we then obtain the constant of the instrument.

Success in the use of this wattmeter requires the current through the series coil to be of the same value as the current through the circuit to be measured; and further, the current

through the shunt coil of the wattmeter must be exactly in step with the P.D. between the ends of the shunt circuit; in other words, the shunt circuit must be strictly non-inductive. This can only be secured by winding the movable coil of the wattmeter with no great number of turns. On the other hand, there is another difficulty when such a wattmeter is employed to measure the power taken up in the primary circuit of transformers at high pressure. In this case, in order to obtain the sufficient magnetic moment in the movable circuit of the wattmeter, we are obliged to pass a relatively large current through the shunt circuit, which means that a large amount of power, in this shunt circuit, is being wasted. Unless this power is at disposal, it may prevent the practical employment of the method. But fortunately there exists another way of dealing with the matter. In the first lecture it was pointed out that when a transformer is being worked on open secondary circuit, or is very lightly loaded, the P.D. between the ends of the primary circuit is exactly opposite in phase to the secondary circuit of the transformer. By interposing a small auxiliary transformer, the primary of which is connected to the extremities of the circuit in which the power to be measured is taken up, we shall still have an arrangement in which the current in the shunt circuit of the wattmeter can be made to be in step with the P.D. between the ends of the inductive circuit; all other arrangements remaining the same, but in which the total power taken up in the wattmeter is very much less than in the former case.

The difference between the direct and indirect methods was shown by supposing that, in the first place, the wattmeter had a shunt resistance which could carry, suitably, one ampère, and that it was required to use this wattmeter to measure the power taken up in the primary circuit of the main transformer at a pressure of 2,000 volts. We should then have to provide a non-inductive resistance capable of carrying 1 ampère at 2,000 volts, or nearly 2,000 watts expended on it. Under these circumstances the power wasted in the shunt circuit of a wattmeter would be nearly 3 H.P. If, however, we do away with the non-inductive shunt resistance, and take an auxiliary (1 H.P.) transformer, capable of transforming down from 2,000 to 100 volts, and put the shunt coil and the wattmeter, together with a small additional resistance across the secondary terminals of this transformer, so arranging the resistance that still 1 ampère flows through the shunt circuit of the wattmeter, we then have the following power absorptions: The wattmeter shunt circuit will absorb 100 watts, and the auxiliary transformer can be made to take as little as 60 or 70 watts, hence the whole arrangement, auxiliary transformer, wattmeter, and additional resistance, only takes up 150 watts, instead of 2,000—a saving of 92·5 per cent. It is clear, therefore, that this combination is more economical than the use of a non-inductive external resistance.

Generally, it may be said, for the purpose of measuring alternating current power, the best instrument to employ is the dynamometer wattmeter, using either one of Siemens's form, in which the torsion of a spring is employed, or a balance form, similar in construction to the ampère balance of Lord Kelvin. In those cases in which the potential differences, between the ends of the circuit in which we wish to measure the power absorption, does not exceed 100 volts, the necessary resistance can be placed in the movable coil itself, winding it as a high resistance, but so that we have as few turns as possible in that coil while obtaining the necessary magnetic moment. We can then apply the wattmeter, standardised as above, to measure the power taken up in any circuit, inductive or non-inductive. When we have to measure the power taken up by any inductive circuits, particularly when we are employing high pressures, as in measuring the power absorption in the primary circuit of transformers, then the best method to adopt is to use an auxiliary transformer in connection with the dynamometer wattmeter, as described.

The lecturer showed an interesting and novel form of wattmeter designed by Lord Kelvin, and especially adapted as a central station instrument, giving indications of power passing through it by means of the movement of a needle attached to the fine-wire coil, the readings being observed on a vertical scale. The main circuit is formed of a double rectangle of copper rod, having sufficient area to carry 200 ampères, and a shunt circuit with two fine wire coils astatically arranged. The main coil is mounted on a slate back, so that the rectangles are horizontal. The shunt coils are on a light but strong aluminium frame, one end of which has a circular knife-edged hole in it, the other end having a straight knife-edge. These two knife-edges are caught by two phosphor-bronze hooks, attached by insulating supports to the outside ends of the double rectangle. By this method of suspension complete freedom from friction is obtained, while the movable system is kept in a definite position without end guides. Each fine wire coil has about 1,000 turns of insulated wire, and its resistance is about 100 ohms. The current is conducted in and out from the movable system by two flat palladium spiral springs, which also supply the restoring force for governing the sensitiveness of the instrument. Not more than $\frac{1}{10}$th of an ampère is allowed to pass through the fine wire circuit. A large non-inductive resistance is rolled on the case of the instrument, which offers a large cooling surface. The scale has nearly uniform divisions, and is graduated to read directly in watts or kilowatts, as required.

ALTERNATE CURRENT WIRING.* †

By W. D. WEAVER.

The following tables, calculated from Kennelly's formula, ‡ give the increase of drop due to impedance in circuits carrying alternating currents.

Each table is for a different frequency, as given: the first vertical column of a table gives the gauge of wire, the horizontal column at the top the distance apart of the two wires of a circuit, and the other columns the co-efficients by which the drop due to a continuous current should be multiplied to find the true drop if an alternating current is used.

To lower the drop due to impedance it will be seen that large wires should be avoided. In inside work particularly a considerable saving of copper may often be made by dividing the feeders of mains into several circuits.

The following method will enable the tables to be applied with an approximation sufficiently close for practical purposes:

1. By means of one of the usual formulæ, calculate, for the given lamps, ampères, or horse-power, the size of the wire (in circular mils) as if a continuous current were to be used, and from a table giving the Brown & Sharp gauge equivalent find the nearest corresponding gauge number.
2. Enter with the gauge thus found that one of the following tables which corresponds with the periodicity used and take out the corresponding coefficient.
3. Multiply the original circular mils by this coefficient and find the corresponding gauge again, as above.
4. Repeat the operation of 2.
5. Multiply the original circular mils by this second coefficient, and proceed otherwise as in 3.

Example: Ampères, 20; volts, 1,000; drop, 5 per cent.; distance, 4,000 feet; periodicity, 130; distance of wires apart, 18 inches.

1. Substituting in the formula $\text{A} = \frac{2{,}150\ \text{L}\ \text{C}}{a\ \text{E}}$, in which A represents circular mils, L the distance, C the current, E the voltage, and a the drop in per cent., we have

$$\text{A} = \frac{2{,}150 \times 4{,}000 \times 20}{5 \times 1{,}000} = 34{,}400,$$

or about No. 5 B. & S. gauge.

2. Referring to Table XXIII., we get the coefficient 1·38.

* From Davis's "Standard Tables for Electric Wiremen," fourth edition (in press). The W. J. Johnston Company, Limited.

† New York *Electrical World*.

‡ $f = \sqrt{1 + \frac{p^2 \pi^2 r^4 (0{\cdot}5 + 2 \log_e \frac{D}{r})}{p^2}}$ (Kennelly on "Impedance," *Transactions* of the American Institute of Electrical Engineers, April, 1893.)

3. 34,400 × 1·38 = 47,472 cir. mils, or between gauges 3 and 4.

4. Referring to Table XXIII., we find the corresponding coefficient to be about 1·44.

5. 34,400 × 1·44 = 49,536, or about gauge No. 3.

If thought necessary a third or fourth approximation may be made by repeating the operations indicated in 4 and 5.

The above rules and tables apply to alternating currents that can be represented by simple sine waves (sinusoids). If the current waves are of more complex type, the drop due to impedance will be increased. The above values are therefore minimum values.

The tables are based on the assumption that the current density in the conductor remains uniform. With the frequencies used the error introduced by this assumption is negligible as relates to the calculation of impedances, as well as to the increase of drop due to the unequal distribution of current in the conductor.

40 PERIODS PER SECOND.

Gauge B. & S.	Distance between wires.											
	3″	6″	9″	12″	18″	24″	36″	48″	60″	100′	500′	1000′
0000	1·38	1·55	1·65	1·73	1·85	1·93	2·05	2·13	2·21	3·13	3·64	3·87
000	1·27	1·39	1·47	1·53	1·61	1·68	1·76	1·82	1·90	2·59	2·99	3·10
00	1·17	1·25	1·30	1·34	1·39	1·44	1·50	1·54	1·58	2·13	2·39	2·50
0	1·12	1·19	1·23	1·25	1·30	1·33	1·38	1·41	1·44	1·83	2·06	2·17
1	1·09	1·13	1·15	1·18	1·20	1·23	1·26	1·28	1·30	1·58	1·75	1·83
2	...	1·09	1·11	1·12	1·14	1·16	1·18	1·20	1·21	1·41	1·53	1·59
3	...	...	...	...	1·09	1·10	1·12	1·13	1·14	1·28	1·37	1·41
4	...	...	...	...	...	...	...	...	1·09	1·19	1·25	1·26
5	...	...	...	...	...	...	...	...	...	1·12	1·17	1·19
6	...	...	...	...	...	...	...	...	...	...	1·11	1·12
8	...	...	...	...	...	...	...	...	...	...	...	...

60 PERIODS PER SECOND.

Gauge B & S.	Distance between wires.											
	3″	6″	9″	12″	18″	24″	36″	48″	60″	100′	500′	1000′
0000	1·74	2·03	2·21	2·35	2·53	2·67	2·86	3·00	3·09	4·55	5·35	5·70
000	1·54	1·76	1·90	2·00	2·14	2·25	2·39	2·49	2·57	3·71	4·34	4·58
00	1·36	1·51	1·61	1·67	1·77	1·84	1·95	2·03	2·08	3·00	3·37	3·42
0	1·27	1·37	1·46	1·52	1·60	1·66	1·74	1·80	1·85	2·51	2·89	3·05
1	1·19	1·27	1·33	1·36	1·42	1·46	1·53	1·57	1·60	2·10	2·38	2·52
2	1·14	1·19	1·23	1·26	1·29	1·32	1·36	1·40	1·42	1·79	2·01	2·10
3	1·09	1·13	1·15	1·18	1·20	1·22	1·25	1·27	1·29	1·56	1·72	1·79
4	...	1·09	1·10	1·12	1·14	1·15	1·17	1·19	1·20	1·38	1·50	1·53
5	...	...	...	...	1·09	1·10	1·11	1·12	1·13	1·27	1·34	1·38
6	...	...	...	...	...	...	...	...	1·09	1·18	1·23	1·26
8	...	...	...	...	...	...	...	...	...	...	1·10	1·11

80 PERIODS PER SECOND.

Gauge B. & S.	Distance between wires.											
	3″	6″	9″	12″	18″	24″	36″	48″	60″	100′	500′	1000′
0000	2·10	2·56	2·82	3·00	3·26	3·40	3·71	3·90	4·06	6·01	7·08	7·54
000	1·86	2·18	2·38	2·51	2·72	2·87	3·06	3·19	3·31	4·87	5·71	6·04
00	1·61	1·81	1·95	2·05	2·20	2·30	2·45	2·56	2·63	3·91	4·42	4·69
0	1·46	1·64	1·75	1·83	1·94	2·03	2·14	2·23	2·30	3·31	3·86	4·46
1	1·32	1·45	1·53	1·59	1·67	1·74	1·84	1·89	1·93	2·66	3·05	3·23
2	1·23	1·32	1·38	1·42	1·48	1·53	1·59	1·65	1·68	2·22	2·53	2·66
3	1·16	1·23	1·28	1·29	1·34	1·37	1·42	1·45	1·48	1·88	2·11	2·43
4	1·11	1·15	1·18	1·20	1·23	1·25	1·29	1·31	1·33	1·62	1·79	1·84
5	...	1·11	1·12	1·14	1·16	1·17	1·19	1·21	1·23	1·43	1·56	1·62
6	...	...	...	1·09	1·11	1·12	1·13	1·14	1·15	1·30	1·38	1·42
8	...	...	...	...	...	...	...	...	...	1·13	1·17	1·19

100 PERIODS PER SECOND.

Gauge B. & S.	Distance between Wires.											
	3″	6″	9″	12″	18″	24″	36″	48″	60″	100′	500′	1000′
0000	2·58	3·12	3·44	3·67	4·00	4·24	4·57	4·81	5·02	7·48	8·82	9·40
000	2·20	2·61	2·88	3·05	3·32	3·52	3·75	3·94	4·07	6·04	7·10	7·51
00	1·84	2·13	2·32	2·45	2·64	2·77	2·97	3·11	3·21	4·88	5·47	5·81
0	1·66	1·90	2·05	2·16	2·31	2·43	2·58	2·69	2·78	3·98	4·63	4·91
1	1·48	1·65	1·75	1·84	1·95	2·07	2·18	2·24	2·32	3·23	3·74	3·98
2	1·34	1·47	1·55	1·61	1·70	1·76	1·85	1·92	1·96	2·67	3·07	3·24
3	1·24	1·34	1·39	1·43	1·50	1·54	1·60	1·65	1·69	2·23	2·53	2·67
4	1·17	1·23	1·27	1·30	1·35	1·38	1·42	1·46	1·49	1·88	2·11	2·17
5	1·11	1·17	1·19	1·21	1·24	1·26	1·29	1·32	1·34	1·62	1·80	1·87
6	1·09	1·11	1·13	1·14	1·16	1·18	1·20	1·21	1·23	1·43	1·56	1·62
8	...	...	...	...	...	...	...	1·09	1·10	1·20	1·26	1·29

130 PERIODS PER SECOND.

Gauge B. & S.	Distance between wires.											
	3″	6″	9″	12″	18″	24″	36″	48″	60″	100′	500′	1000′
0000	3·25	3·97	4·40	4·70	5·14	5·45	5·89	6·20	6·48	9·68	11·4	12·2
000	2·73	3·29	3·65	3·88	4·23	4·49	4·80	5·05	5·23	7·81	9·19	9·72
00	2·23	2·65	2·90	3·08	3·35	3·51	3·77	3·95	4·09	6·22	7·06	7·51
0	2·00	2·34	2·53	2·68	2·88	3·04	3·24	3·39	3·51	5·10	5·96	6·33
1	1·73	1·98	2·13	2·24	2·43	2·53	2·71	2·79	2·89	4·13	4·79	5·10
2	1·54	1·72	1·84	1·93	2·04	2·13	2·25	2·36	2·41	3·37	3·91	4·14
3	1·38	1·53	1·60	1·67	1·76	1·82	1·92	1·98	2·04	2·77	3·19	3·37
4	1·27	1·37	1·43	1·47	1·54	1·59	1·65	1·70	1·74	2·30	2·62	2·71
5	1·19	1·26	1·30	1·33	1·38	1·41	1·46	1·50	1·53	1·94	2·19	2·29
6	1·14	1·17	1·20	1·23	1·26	1·29	1·32	1·34	1·37	1·67	1·85	1·93
8	...	...	...	...	1·09	1·13	1·15	1·16	1·17	1·32	1·41	1·45

REVERSAL IN INFLUENCE MACHINES.

BY T. H. MURAS.

THE reversal of the action of a Toepler-Holtz machine, such as that made by Voss, appears to be due to the accumulation of opposing charges on the inside of the stationary plate, opposite the neutralising brushes, and can, I find, be completely prevented by applying foil and paper coatings to the inner surface of the stationary plate, and connecting them by foil strips to the charging rods. The length of spark obtainable is reduced somewhat, owing to leakage from the inside coatings to the surface of the rotating disc. I have obtained sparks, 13½ cm. long, regularly, from a machine having a rotating disc of 46 cm. diameter. The inside coatings may be of paper only, with varnished edges; longer sparks can then be obtained, but the machine sometimes reverses. In either case, the fixed and moving plates should be considerably further apart than usual. The outside field plates must be retained, to prevent opposing charges accumulating outside of the stationary plate. In the machine I have tried, no leakage occurs from the inner field-plates to the neutralising rod around the edge of the rotating disc; leakage frequently occurs at the corresponding parts of Wimshurst machines, but the small sectors of the Toepler-Holtz machine are not conducive to it. Larger ones, such as are used in Wimshurst machines, make the machine more independent of damp.

An obvious addition to the modified machine is a second rotating disc, at the outer side of the stationary plate, with collecting and neutralising combs. But this to some extent does away with the simplicity of construction of the machine, as compared with machines having pairs of oppositely rotating discs, such as Mr. Wimshurst's. The machine may conveniently be driven at a high speed by a motor, the disc being of ebonite.

STEAM ENGINES AT THE WORLD'S FAIR.

IV.

IN continuation of this series in *Cassier's Magazine*, Mr. Clark refers to the tests it has been proposed to make with several of the exhibited engines. The Allis quadruple and the triple Corliss of Fraser and Chalmers are to be tested for America, also the Buckeye. The Germans will have the Schichau triple engine taken as representative of Continental practice, but it is a little startling to find the Galloway superposed engine set down as a representative English engine. It is not this: it is a fancy design of makers who have never really been in the field as builders of engines of the factory type, and we say this without conveying any slight upon its makers. The engine may be perfectly good, and quite likely will show a good record for its size and speed, but it does not represent English practice half so closely as the Allis engine would do the American, for it is a solitary type of its own and in no way representative.

There is a vertical Allis engine which will be tested, in which governing is like that of the gas engine; steam is shut off entirely for a stroke or more.

In the Fraser and Chalmers four cylinder triple-expansion engine, a useful feature is introduced in the shape of a cut-off upon the intermediate and last cylinder which are operated through a cataract from the governor. Slow variations cannot be felt through the cataract, but a sudden change of load would be felt and would vary the cut-off merely for a time, or until the receivers and later cylinders had begun to feel the result of the action of the governor upon the high pressure cut-off. This avoids racing or flagging.

In the engines of the Atlas Engine Works, of Indianapolis, we note what may be termed a gridiron modification of the Corliss valve, whereby less oscillation gives a large port opening and several edges of admission, the ports also being gridirons. The motion of these valves is positive, and is by means of cams acting on friction rollers on the short crank arms of the valve spindles. The small oscillation lends itself to this method which has displaced the usual release gear because of the high speed—150 revolutions per minute.

The Westinghouse Company show, curiously enough, several entirely new engines, steeple tandem *double acting* compounds to run at 200 revolutions, and to indicate 1,000 H.P., with cylinders 22 inches and 37 inches respectively and 22 inches stroke, the larger cylinder having a flat slide valve, and the smaller a piston valve. Have the Westinghouse Company at last found out that success in a double-acting engine is a matter of design? With this the descriptions appear to have come to a conclusion.

Many of the engines contain novelties and details of interest, but on the whole there is not a wide difference between American and English practice in stationary engines. Excepting in high speed engines, wherein England is represented by the Willans engine, there is no representative English engine to be seen at Chicago such as could be compared with the Allis engine, and we think this is to be regretted, even though we are aware it has been caused by the McKinley tariff.

THE DEVELOPMENT AND TRANSMISSION OF POWER FROM CENTRAL STATIONS.*

BY PROF. W. CAWTHORNE UNWIN, F.R.S.

II.

THE STORAGE OF ENERGY AND THE DEVELOPMENT OF ENERGY BY WATER-POWER.

OF all central stations electrical central stations are those which have to meet the greatest fluctuation of demand for energy, and the waste so occasioned has compelled electrical engineers more than any others to seek for means of storing energy.

To completely meet a fluctuating demand by generators of energy worked at a uniform rate, there must be storage of energy satisfying two conditions. Twenty-four hours may be taken as the natural period of the fluctuation of demand for energy. In each 24 hours there will be two periods, one in which the demand falls below the average demand, and one in which the demand exceeds the average demand. The excess of energy supplied during one period will, on the average, be equal to the deficiency in the other period. If the generators are worked at a uniform rate, then all the energy supplied in excess of the mean demand in one period must be taken from storage, and must have been put into store during the period in which the demand fell below the mean demand. But this is not the only condition to be satisfied. With some kinds of storage, the rate at which energy can be taken out of store is unlimited. In other cases it is limited, and then the storage must be so arranged that the rate at which energy can be taken out of store is equal to the difference between the maximum rate at which energy is required and the mean rate.

Gas-holder Storage.—The gas engineer is happy in having a convenient and cheap means of storage. Taking 25 cubic feet of gas as capable of yielding one effective horse-power hour of energy, it appears that gas-holders cost about 5s. 6d. per effective horse-power stored. Mr. Trewby puts the cost of gas-holders at a London station at £10,000 per million cubic feet of gas supplied per day. In that case such a station works virtually at 1,666 effective horse-power, and the cost of the gas-holders is £6 per effective H.P., reckoned on the average rate of supply throughout the year. Here allowing 10 per cent. for interest and depreciation, the storage adds about 12s. per effective horse-power to the annual cost.

Accumulator or Battery Storage.—From data given me by Prof. Ayrton, it appears that eight Epstein cells, tested in the laboratory, would work at 1 horse-power, and store a charge for 2½ horse-power hours. The cells cost, without allowance for buildings, insulation, or switching arrangements, or for waste of energy, £20. That is, the bare cost of the cells amounts to £20 per horse-power reckoned on the maximum rate of working, or to £8 per horse-power hour stored. Suppose a station working at an average of 500 horse-power. The maximum demand in the 24 hours would be 2,000 horse-power, of which 1,500 would have to be supplied from the battery. The cost of the battery to supply energy at the necessary rate would be £30,000. During 24 hours the quantity of energy supplied would be 12,000 horse-power hours, half of which must be stored. Batteries of sufficient capacity would cost £48,000. Here the latter condition determines the cost. Taking interest at 5 per cent., and maintenance and depreciation at 12½ per cent., the annual cost of the battery would be £8,400, or nearly £17 per horse-power of average rate of working of the station. This is the bare cost of the cells without buildings, adjuncts, or reserve.

In a project for lighting Frankfort-on-Main, Mr. Oskar von Miller and Mr. Lindley provided large secondary battery stations. The batteries had a capacity of 11,700 ampère-hours, and were capable of supplying a current of 3,500 ampères at 100 volts. The batteries, with wood platforms, insulation, &c., were taken to cost £25,100, and the buildings for them £11,600. This is equivalent to a capital cost of £23 per horse-power hour of storage capacity, or £78 per horse-power reckoned on the maximum rate of working.

Thermal Storage.—Lately, Mr. Druitt Halpin has proposed a system of thermal storage, which appears, in many respects, to meet the conditions required; this plan is to communicate heat in boilers to a body of water. The heated water is stored in reservoirs under pressure. From the reservoirs steam is taken through a pressure-reducing valve exactly when and in what quantity it is required. Mr. Halpin proposes that the heat reservoirs should be under a pressure of 265 lbs. per square inch (absolute) when fully charged, the corresponding temperature being 406° Fahr. He proposes that the steam engines should be worked at 130 lbs. per square inch, corresponding to 347° Fahr. The total heat stored when the reservoirs are fully charged is the difference of the total heat of the water at 406° and 347° Fahr., or the heat due to a range of temperature of 59°. Every pound of water falling in temperature through that range will yield 61 thermal units of heat. But the total heat required to generate a pound of steam at 130 lbs. per square inch from water at 347° is 868·8 thermal units. Consequently 14¼ lbs. of water falling in temperature from 407° to 347° will yield a pound of steam. To allow for radiation, loss, and imperfect working, this may be taken at 16 lbs. of water per pound of steam. A simple cylindrical reservoir, 8 feet in diameter and 30 feet long, will contain 84,000 lbs. of heated water. Such a reservoir would be capable of generating, under the conditions supposed, 5,250 lbs. of steam at 130 lbs. per square inch.

The steam consumption may be taken to be, per effective horse-power, 18 lbs. per hour in condensing, and 25 lbs. in non-condensing engines. Hence one such reservoir would store 286 effective horse-power hours if the steam is used in condensing engines, or 210 effective horse-power hours if the steam is used in non-condensing engines.

If the reservoir were fully charged and discharged daily, it would yield 104,400 and 76,660 effective horse-power hours of stored energy yearly in the two cases.

A reservoir, 30 feet by 8 feet, would cost, erected, with ample allowance for buildings and appendages, £470. As it is not exposed to fire, its deterioration would not be considerable, and 10 per cent. would be sufficient to cover interest, maintenance, and depreciation. Hence, the first cost of such reservoirs, reckoned on their storage capacity, and the annual cost per H.P. added to stored energy by the cost of storage, would be as follows:—

	Cost of reservoirs per effective H.P. hour of storage capacity.	Annual cost of storage per H.P. supplied from reservoirs.
	£	£
Condensing plant	1·64	3·94
Non-condensing plant	2·24	5·37

* Abstract of Howard Lectures delivered before the Society of Arts.

The cost in the last column is the cost due to 8,760 effective horse-power hours annually.

Water-power.

It appears, from a report by Mr. Weissenbach, that in 1876, 70,000 horse-power derived from waterfalls were applied in manufacturing in Switzerland. Probably the amount now employed is at least 80,000 horse-power. It is estimated that the total available water-power in Switzerland amounts to 582,000 horse-power. Putting the annual value of a horse-power at £6, this represents an annual value of £3,500,000. Used to replace steam power, it would save annually 1,250,000 tons of coal. It is stated that at the present time Switzerland pays £800,000 annually to other countries for coal. Nearly the whole of this expenditure could be saved if its natural wealth of water-power was utilised.

The money value of the water-power utilised in the United States is very considerable. From the returns of the tenth census it appears that in 1880 there were 55,000 water-wheels and turbines of an aggregate of 1,250,000 H.P. At £5 per annum the water-power utilised is worth £6,250,000 a year.

The comparison of the relative amount of water and steam-power is interesting. Taking the whole of the United States, 36 per cent. of the power used in manufacturing was at that date water-power, and 64 per cent. steam-power. In certain industries the proportion of water-power was greater. In the manufacture of cotton and woollen goods, of paper, and of flour, 760,000 horse-power derived from water, and 515,000 horse-power derived from steam, were employed. In the North Atlantic division 4·81 water H.P. are utilised per square mile.

In Holyoke the whole of the factories in the town are worked by water-power, and the system is strictly a distribution of power to many consumers at a rental strictly proportional to the amount of power used. From above a weir a first canal supplies water to the highest line of mills. From these mills, after driving turbines, the water is discharged into a second canal, which is a supply canal to a second line of mills. The tail races of these mills discharge into a third canal feeding a third line of mills, and there are still other mills worked by the water before it returns into the river. The power now utilised is 15,000 H.P. by day, and 8,000 H.P. at night. Altogether there are about 53 mills.

With the grant of land for a mill there was leased the right to use a definite portion of the water. A "mill-power" is defined as 38 cubic feet of water per second on a fall of 20 feet during 16 hours per day. This gives about 63 effective horse-power on the turbine shaft.

Mr. Swain puts the average cost of steam-power in the States, in favourable localities, at £4 per horse-power per annum, and that of water-power at about £2 per horse-power per annum. Both these estimates are so low, that it may be suspected that they are based rather on the nominal power of the plants than on the average actual horse-power used throughout the year.

It appears that at Geneva, for the first groups of turbines erected of 840 horse-power, and for the river works then completed, the capital cost amounted to £60 per effective horse-power. The groups of turbines subsequently erected have cost only £19 per horse-power. The mean cost, when the present works are completed, will amount to £27 per effective horse-power. In this case the water costs nothing If we allow 5 per cent. for depreciation, repairs, and working expenses, and 10 per cent. for interest on capital, the cost per horse-power per annum will only amount to £4. In the new works below Geneva, where 12,000 horse-power are to be utilised, it is estimated that the whole cost for turbines and structural works will amount to £60 per horse-power for the first 2,400 horse-power. When the whole installation is completed, the capital cost will be only £27 per horse-power.

TRANSMISSION AND DISTRIBUTION OF ELECTRICAL ENERGY.*

In discussing this topic at the International Congress of Electricians, Chicago, Professor George Forbes said, each type of transmission has its own sphere of action. While the continuous current could be used for transmission at a distance, it possessed none of the beauty of the diverse applicability of the alternating current. There was trouble at the commutator and in insulating the armature, which must be the revolving part. In the alternating generator the armature might be stationary and insulated with oil if necessary. The continuous current rotating transformer was not to be compared with the alternating transformer. The speaker had had very long experience with synchronising alternating machines used as motors, and had a very high opinion of them, but they were only applicable in cases where power is required constantly; but where required to start, stop and reverse, the synchronising system was practically out of the question. So far as he had studied the polyphase systems, and he had given them a great deal of personal and practical study, he considered the two-phase system the better. The three-phase introduced complications by the inter-connection of the three conductors; it introduced trouble in locating the circuit and in testing, and in correcting faults which might arise. He preferred a two-phase system with separate independent circuits, which were more easily managed, tested and regulated. Moreover, when the three circuits were inter-connected, each one had an influence on the other, and the unbalancing on one side of the circuit greatly affected the others. Thus, if in a three-phase system circuit A be overloaded, and B and C not loaded, then B might be at a higher voltage than A; but C would have a higher voltage than either of them. This was a fact not generally known, and was a serious drawback to the use of the three-phase system, condemning it for lighting purposes. I had advised the Cataract Construction Company to reject the three-phase system, and to build their first dynamos with two-phases, because I believed that in this manner those dynamos could be used in every direction in which alternating current transmission would be developed in the next ten years. The two-phase system had the advantage not only of being able to work two-phase motors, but, as it gave two single-phase circuits, it would be able to work all the single-phase machinery which would ever be invented in the future; besides, a dynamo constructed on the two-phase plan would give the single-phase cheaper than if it were constructed with one circuit.

I feel that it is a very fitting time to say a few words about the condition of affairs at the present moment in the way of utilising the Falls of Niagara. A great deal of time and thought has been given to selecting the best system to be adopted for this work, and for a long time the question was open whether the power should be used directly by wheel pits communicating with each separate mill that was going to take the power. It was a resolution of the deepest importance which was arrived at by the President of the Cataract Construction Company when, after having inspected all that was being done in Europe, and knowing all that was being done in America in the way of transmission of power, he telegraphed to the New York office that it must be a question of starting central stations at the Falls of Niagara. That was the first step that was taken. The question was whether the power should be transmitted by compressed air, by rope transmission or by electricity, and I may say that for a long time there was a great preponderance of opinion in favour of compressed air. Finally, we have all to congratulate ourselves that the resolution was adopted to do the whole of the transmission by means of electricity.

In the year 1890 a number of plans were invited from different engineers and manufacturing firms as to the best means of utilising this power. These plans were submitted before an international congress consisting of members well known in the engineering and electrical world of all countries, who met in London at the beginning of 1891. At that time there was one report which used these words: "It will be somewhat surprising to engineers in general, as it was to myself, to find that the only possible means of transmitting this power to Buffalo, and the best means for using it in the neighbourhood of the Falls, is by means of the alternating current." I made that statement in my report after having considered carefully every means which was then available. I am glad to say that I have never had any reason to change my opinion from the year 1890 to the present day. I proposed then that the work should be done by alternating currents generated in two phases; that these should be sent along separate circuits at high voltage; that the transformers should be used for reducing the pressure down and introducing a safe pressure into the workshops; that in the workshops synchronising alternating motors should be used in some cases, and that in other cases two-phase motors should be employed, and that in the cases where the direct current was necessary, alternating motors should be used to drive continuous current dynamo machines. That was in the year 1890, and in the present year, 1893, there is hardly a change to be made upon that system which has been proposed.

I mentioned the chief considerations objectionable in the use of continuous currents for the transmission of power at Niagara Falls. There are many cases where the continuous current is the most desirable to use for transmission of power, and the chief disadvantage is the necessity of putting all your motors in series at the receiving end of the line. But in all these cases that come before the practical engineer, the most important thing to consider is the question of cost. At every stage of the working out of the scheme, the cost is really the thing that governs the engineer most of all, and it is fortunate when we find that the best harmonises with the cheapest, as sometimes happens in great engineering works, and as I am glad to say, it has happened in the case of this great work of the utilisation of Niagara Falls. After the Congress closed its labours, and when electricity was decided upon for the purpose, projects were asked for from all the greatest firms in the world. They were asked to submit plans for dealing with this problem. Some were continuous current, and some were alternating current. The greatest difficulty was experienced in nearly every case by those who were proposing continuous currents to meet the requirements in any way whatever, and in every case the cost was largely in excess of the cost with alternating currents. One of the things which we have decided upon is that we are to use the same system for the distant transmission as we are to use for the near-by transmission. Nearly all, when they have begun to tackle this problem, have thought that it was desirable to use a lower voltage for the near-by transmission. One or two thousand volts seemed to be about right when you were only transmitting a distance of a mile or two, whereas 10,000 or 20,000 volts was considered nearer right for the distant transmission. But the advantages which we gain by using the higher pressure to a great distance are also gained in using the near-by distribution. Moreover, in all these cases it is almost impossible to grasp the full conditions of the problem until you come down to the details. Suppose you do start with 1,000 volts for a distribution, say, of the first 50,000 H.P. in the neighbourhood of the Falls, you will find that the mass of conductors that you have to deal with is something simply impossible. The most convincing argument that I was able to adduce on this point was by drawing a full scale section of a subway carrying the conductors which would be necessary at 50,000 H.P, and it filled a large subway through which a man could walk. It filled that subway up with conductors in such a way as to show, without any further demonstration, that it was unpractical. Moreover, the simplicity of having the whole of the

* From the *Electrical Engineer* of New York.

system all in one voltage is something which cannot be over-estimated, and this is the way in which we propose to work.

I am glad to feel that the universal opinion is in favour of the adoption of alternating currents. I can only quote one man of any eminence who seriously and persistently considers that it is the greatest mistake to use the alternating current for such a purpose. I will not mention that gentleman's name, and it is a very well-known name, one that bears the greatest influence; so great an influence that I and those with whom I have been associated have considered with the utmost care every single point in the matter before rejecting the advice that has been given us. The opinion was stated in a general way, but the concrete way in which it was put by this authority was that on the top of our vertical shafts which comes from the turbines we should have a building four stories high for each turbine. Each floor should be insulated completely from the rest of the building. At each floor there should be a large toothed wheel driving five other toothed wheels, on each one of which should be a dynamo of vertical shape. We should thus have twenty dynamos, each of 1,000 volts, all continuous current dynamos, all connected in series. That plan we have considered most carefully, owing to the source from which it came, and we have rejected it. We are now going ahead with the alternating current, and at every point the question of cost has been considered, and the results which we have arrived at, I believe, are the best, and I may also say that they are certainly the most economical.

In the year 1890, at the time that I proposed the adoption of synchronising alternators in some cases and Tesla motors in other cases, there were comparatively few who had much experience with either one or the other of these alternating motors. The Tesla motors I had fortunately been able to see at the Pittsburgh works of the Westinghouse Company, and they had been placed at my disposal for experiments, and I put a high value on the outcome of these motors and what they would be developed into. I regret to say that during the intervening years there was very little done in the way of developing these Tesla motors at Pittsburgh. In the meantime the question was being taken up in other countries, and in Europe, at the time of the Frankfort Exhibition, there was a great deal of multiphase work shown in action. This directed the attention of the world to it, and I am glad to say now that in America also the multiphase motors have made progress. Prof. Silvanus Thompson said that he thought multiphase motors would disappear from general distribution, and that the single phase motors with a multiphase means of starting the motor might be the more universal way adopted. That is one of the possibilities of the future. There are several possibilities of the future that we must consider in any very great scheme like that which I am speaking of at the present moment, but in the meantime we must deal with the possibilities of the present. I consider that the multiphase motors at the present moment are not only a possibility, but are a valuable adjunct to the other uses for which the alternating current can be used. Now, a great part of the work in any large system of distribution like that is the continuous working, day and night, or from early morning till late night. A mill is started in the morning and never needs to be shut off during the day, and there are other mills of a character most likely to be attracted to such a situation which run day and night, from week's end to week's end. The largest consumers of power which we have at present are the pulp mills for making wood pulp for paper, consuming thousands of horse-power, and next to these come the electric deposition works, where power is required from week's end to week's end, continuously running. In these cases, if it is simply power you require, a synchronous motor is admirably adapted and thoroughly satisfactory, but in all ordinary workshop practice where we wish to be stopping, starting and reversing our machinery, the most convenient alternating motor, which is a thing, not of the future, but ready for practical use at the present moment, is the multiphase motor. It is possible to do without the multiphase motor perfectly well, but it is a valuable adjunct at the present moment.

NEW PATENTS—1893.

23,101A. '92 "Improved methods of recovering zinc from the waste products of galvanic batteries." C. A. J. H. SCHROEDER and H. E. R. SCHROEDER. (Date claimed under Patents Rule 19, December 15th, 1892.) Dated September 29th.

23,101B. '92. "New or improved galvanic batteries." C. A. J. H. SCHROEDER and H. E. R. SCHROEDER. (Date claimed under Patents Rule 19, December 15th, 1892.) Dated September 29th.

17,972. "Improvements in make and break contacts for electric bells, fire and burglar alarms, and other purposes." A. MILLS. Dated September 25th.

17,980. "Improved process and means used therein for the electrolytical production of gases." P. B. W. KERSHAW. Dated September 25th.

17,981. "A magneto-electrical igniting apparatus." J. DRACH. Dated September 25th.

17,992. "An improved composition and the production therefrom of blocks, slabs, tubes, vessels, or like articles, more especially intended for the production of paving blocks or slabs, or conduits for electric cables." C. JOST. Dated September 25th.

18,019. "Improvements in electrical switches." J. H. TUCKER. Dated September 26th.

18,058. "Improvements in microphones." Sir C. S. FORBES, Bart. Dated September 26th.

18,064. "Improvements in electric switches." THE EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY, LTD., and P. H. BELL. Dated September 26th. (*Complete.*)

18,066. "Improvements in and appertaining to adjustable supporters for electric lamps and other objects or articles." W. R. LAKE. (Communicated by O. C. White, United States.) Dated September 26th. (*Complete.*)

18,069. "An improved form of electrical switch." W. H. SHARPLESS. Dated September 26th.

18,115. "A new or improved electric arc lamp specially applicable for projecting purposes instead of the limelight." F. J. BORLAND. Dated September 27th.

18,117. "Improvements in brush holders for dynamo-electric machines and electric motors." H. INGRAM and A. INGRAM. Dated September 27th.

18,150. "A portable secondary battery lamp for use in mines and other places." V. C. DOUBLEDAY. (Communicated by M. Sussmann, Germany.) Dated September 27th.

18,165. "Improvements in and connected with electric switches for series circuits." A. A. GOLDSTON. Dated September 27th.

18,170. "Improvements in electrical contacts." J. S. RAWORTH. Dated September 27th. (*Complete.*)

18,173. "Improvements in apparatus for the electrolysis of chlorides and other salts." J. HARGREAVES and T. BIRD. Dated September 27th.

18,175. "Improvements in switchboards for telephone exchanges." O. FRANZ and G. OTTO. Dated September 27th. (*Complete.*)

18,188. "Improvements in or relating to electric telephones." T. SLOPER. Dated September 28th.

18,291. "Improvements in or appertaining to submarine telegraph and like cables." H. A. TAYLOR and J. A. L. DEARLOVE. Dated September 29th.

18,323. "Improvements in electric batteries." H. H. LEIGH. (Communicated by A. Chevallier, France.) Dated September 29th. (*Complete.*)

18,346. "Improvements in electric switches." E. W. P. COMMINS. Dated September 30th.

18,363. "Improvements in electroplating." S. O. COWPER-COLES and Sir B. W. WALKER, Bart. Dated September 30th.

18,375. "Improvements in or relating to the arrangement of electrical circuits and switches." J. A. MONTEALEGRE. Dated September 30th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1892.

310. "Improvements in or relating to joints and attachments for concentric armoured electric conductors, and the methods of making the same." J. D. F. ANDREWS. Dated January 6th. For the purpose of making a joint connecting two lengths of concentric or armoured cable, the inventor first binds and solders a wire round the outer conductor or armouring at suitable points so that its ends shall remain in position and from such point of binding cut away the outer conductor and taper down the insulating material until the inner conductor is exposed, join to this the inner conductor of the second length or branch as the case may be, which has been prepared in an exactly similar manner. He then wraps this joint with insulating material which may be prepared for vulcanisation and over this he puts a sheath of thin sheet copper overlapping the ends of the outer conductor he now applies to the joint a mould of the required shape and depth and pours in a metal fusible at a low temperature making the metallic joint complete and at the same time vulcanising the insulating material. 3 claims.

843. "Improvements in and connected with mounting incandescent lamps for safety purposes, particularly applicable to electric miners' safety lamps." T. COAD. Dated January 15th. According to this invention the incandescent lamp is held on a flexible support, so as to offer no resistance to a blow if it should be knocked against anything, and any action which moves it out of its normal position breaks the electric circuit, and so immediately puts out the lamp, which relights on coming back to its normal position. 1 claim.

936. "An electro-mechanical device for producing corresponding positions in transmitting and receiving apparatus." S. SCHUCKERT and A. WACKER. Dated January 16th. Claim:—The combination of a transmitter containing a circularly arranged series of contact pieces and a pair of contact slides and contact rings, adapted to connect the said contact pieces in pairs with the poles of a source of electricity, with a transmitter containing a circularly arranged series of coils connected with each other and adapted to produce a relative angular motion between itself and a diametrically arranged magnet, and a group of conductors equal in number to the contact pieces, each conductor connecting one of the said contact pieces of the transmitter with one of the junctions between consecutive coils of the receiver, the whole being adapted to operate substantially as described and for the purposes set forth.

1,880. "Improvements in electrical sound producing apparatus." A. B. WOAKES. Dated February 1st. The object of this invention is to produce an apparatus, answering the purpose of a bell, gong, or sirene, that can be conveniently worked by the electric current supplied for the purpose of public or private electric lighting, but it is adaptable to current obtained from other sources and may in addition be used for any purpose in which a musical note is or in which

musical notes are required. For this purpose the inventor makes use of an apparatus similar in all essential details to the ordinary telephone receiver or any of its modifications. 3 claims.

2,981. "Improvements in electro-medical appliances." P. A. CRAVEN. Dated February 16th. Consists in the employment of a series of alternate copper and zinc or other metallic plates or discs electrically connected in pairs, and arranged in the form of a band or strip, and enclosed within or between suitable absorbent fabrics in such a manner that the two end or terminal discs only are exposed, and these are intended to be applied to the parts affected. 1 claim.

3,120. "Improvements relating to galvanoplastics or the electrodeposition of metals." P. H. BERTRAND. Dated February 17th. Consists in the use of orthophenol-sulphurous acid, metaphenol-sulphurous acid, and paraphenol-sulphurous acid, which are powerful solvents of salts of tin and easily soluble in water, and can be advantageously employed in place of pyrophosphate of soda for all galvanoplastic plating purposes. 1 claim.

3,233. "Improvements in apparatus to be used in connection with electrically driven machines." W. S. RAWSON, C. S. SNELL, and WOODHOUSE & RAWSON UNITED, LTD. Dated February 19th. The inventors employ a magnetic cut-out, by which a current is broken as soon as it has reached a predetermined point. 4 claims.

4,068. "Improvements in telephones." J. B. S. BOOTH and E. J. FALCONER. Dated March 2nd. Relates to electro-magnetic telephones of that type or class in which the poles of a permanent or electro-magnet or magnets are arranged on opposite sides of the diaphragm or diaphragms. The inventors arrange a coil upon each pole or pole piece of the magnet or magnets, and join them up in the line circuit preferably in parallel or derivation. Each of the coils is wound and joined in the same direction. The coils may, however, in some cases be joined in series instead of in derivation. 2 claims.

4,158. "Improvements connected with electric circuits for varying, regulating, or controlling the pressure of electric currents therein." H. EDMUNDS. Dated March 2nd. The inventor employs in series with the main at the place or places where the pressure is to be controlled, augmented, or reduced, a generator of electricity which is capable of supplementing or reducing the pressure of the mains. For example, in charging secondary batteries from a main supplied with current of constant or partially constant pressure, he places in series with the main leading to and from such batteries a dynamo which is capable of supplementing the pressure of the current in the mains to an extent sufficient to enable the batteries to be charged by the current which, if not so supplemented would be of insufficient pressure to charge them. 4 claims.

4,258. "Improvements in the wearing parts of dynamo-electric machinery." W. L. SPENCE. Dated March 4th. Consists in a compound brush block of copper or other suitable metal and carbon. Two blocks or plates of carbon are taken, of appropriate size, and between them is sandwiched a sheet of copper or other suitable material of corresponding dimensions; the three pieces are then riveted or otherwise fastened together and secured to the supporting device in any suitable manner. 4 claims.

4,779. "An improvement connected with electric arc lamps." J. J. RATHBONE and J. HOUGHTON. Dated March 10th. Consists of a rolling armature to roll upon the end of a solenoid core or of an electro-magnet. 2 claims.

4,841. "Improvements in the methods of driving electric railway trains." W. L. SPENCE. Dated March 11th. The inventor combines with a transformer an accumulator system in the shape of one or more heavy fly-wheels (which may, of course, be integral with the armature core), mounted on the rotating shaft, with the definite purpose of relieving the supply mains of the excessive strains involved in starting a train from rest. When the train is stopped for merely a short time, the transformer is allowed to continue running and only cut off the secondary current, *i.e.*, from the motors. Hence the transformer will revolve at a somewhat more than normal speed, and the energy absorbed will, to a large extent, be stored in the fly-wheel, and will be given up to the circuit when the motors are again switched on. Also relates to a method of braking by sending a direct current through the magnet coils of the dynamo, or short-circuiting the same. 4 claims.

5,141. "Multiple fuses and switch for use in electric circuits." C. S. SNELL and WOODHOUSE & RAWSON UNITED, LTD. Dated March 16th. Relates to the combination of a contact making brush and contact plates, with a supplementary plate so arranged as to be common to one end of a set of fuses, which at the other end are attached to the individual contact plates afore-mentioned. 3 claims.

5,161. "An improved telephone cabinet." J. S. VOST and F. R. FISHER. Dated March 16th. Consists in making the sides, as well as the door, of double casing, in which are inserted sawdust, wool, cotton, or other substance or material for the purpose of deadening sounds or noises which may be going on outside the cabinet. 2 claims.

5,526. "Electrical apparatus for producing flashes." SIEMENS BROTHERS & CO., LTD., and F. G. BAILY. Dated March 21st. In this apparatus an electro-magnet has its armature attached to a spring lever carrying a carbon, which, when the apparatus is inert, is pressed by the spring against a stationary carbon. The one terminal of a battery, dynamo machine, or other source of electricity, is connected through the coil of the electro-magnet and the spring lever to the carbon carried by the lever, and the other terminal is connected to the stationary carbon. When the circuit with the source of electricity is closed, the electro-magnet, being excited, attracts its armature, moving the spring lever, whereby the one carbon is rapidly withdrawn from the other, causing a brilliant flash. The circuit being opened by this separation of the carbons, the armature is no longer attracted, the spring causes fresh contact of the carbons, which is again broken with a flash, and thus, so long as connection with the source of electricity is maintained, a succession of flashes is produced. 1 claim.

5,528. "Improvements in coin freed telephonic apparatus." H. S. J. BOOTH. (Communicated from abroad by C. Hermann, of Paris.) Dated March 21st. Relates to apparatus so arranged that a person on introducing a coin of predetermined value, can for a certain time be in telephonic communication with the distant place, or with one or other of a number of such places. 3 claims.

6,253. "Improvements in or connected with electric railways and tramways." Lord A. S. CHURCHILL. Dated March 31st. The inventor makes the brushes or contact makers on the vehicle of considerable length, which allows of the surfaces on the ground being comparatively small, and distant from each other. Thus, if each contact maker on the car is, say, 25 feet long, the surfaces on the ground connected to one pole of the dynamo may be 20 feet, or nearly so, apart, as it is only necessary for the contact maker to rest on one surface at a time. If, therefore, the surfaces connected to one pole of the dynamo be placed midway between those connected to the other, then there will be some 10 feet between any two surfaces of opposite polarities, a space it is practically impossible to bridge over accidentally. 2 claims.

6,405. "An improvement in secondary voltaic batteries." D. URQUHART and J. M. SMALL. Dated April 2nd. Claims:—1. A pair of electrodes for a secondary battery consisting of a lead wire having its end parts helically twisted, one of these helices gilt or coated with non-oxidisable metal, and both having their interstices filled with lead oxide or other suitable material, the one helix of the wire forming the positive electrode of one cell, and the other forming the negative electrode of the next cell, substantially as described. 2. The arrangement of sets of cells having electrodes such as are above referred to, in portable form with suitable connections, substantially as described.

9,496. "Improvements in telephones." Sir C. S. FORBES. Dated May 19th. Consists in mounting the tympans very near to each other in a narrow ring or chamber, the extensions being regulated by special devices. 7 claims.

12,468. "Improvements in electricity meters." J. EDMONDSON and J. OULTON. Dated July 6th. Consists in preventing sparking by combining a resistance with a condenser and the electric circuit of an electro-magnet. Also consists in providing for stopping the pendulums or balances when the supply current is intermitted, and for starting them when the current is again switched on. 6 claims.

16,980. "Improvements in connections for electrical accumulators and other similar purposes." J. J. ROBINS. Dated September 23rd. The inventor makes the primary conductor of copper (or other high conducting metal) either of a solid, tubular or stranded sectional shape, and then covers the same with a more or less coating of lead. 1 claim.

18,807. "Electrodes for secondary batteries." E. ANDREOLI. Dated October 20th. The inventor casts fused salts of lead, such as chloride of lead, between two grids of any convenient shape or size, made of lead or lead alloy, which are fixed on each shell of a mould, at a suitable distance one from the other, so that there is a certain space between them which is filled by the fused chloride or other lead salt. At the same time, the interstices, cavities, or cells of the two grids are also filled with the fused salts. 5 claims.

21,613. "Improvements in telephonic transmitters." A. GROPER. Dated November 26th. Claim:—In a telephonic transmitter of the type described, the disposition of a mica diaphragm and a carbon diaphragm so that an air space exists between them, the mica diaphragm being adapted to receive sound waves and to transmit them to such carbon diaphragm, which in turn communicates them to a number of carbon balls adapted to be kept in contact with such carbon diaphragm, whereby such carbon balls are subjected to varying pressures, and the electric current passing through them to a varying resistance.

22,639. "Improvements in glass vessels for secondary batteries or accumulators." H. KROEKER. Dated December 9th. Claims:—1. A glass vessel for containing the electrodes of secondary batteries or accumulators having oppositely-placed coincident grooves and projections arranged vertically and adapted to receive and suspend the said electrodes at a suitable distance apart, substantially as and for the purpose shown and described. 2. A glass vessel for containing the electrodes of accumulators having vertical grooves, and a recessed shoulder on opposite sides adapted to receive and carry the said electrodes in an insulated manner, combined with a glass cover capable of being sealed, substantially in the manner and for the purpose described and illustrated.

22,958. "Improvements in lightning arresters." W. R. GARTON and J. C. DANIELS. Dated December 13th. Consists in a solenoid provided with an armature arranged to slide in the solenoid provided at one end with a guide rod which receives a flexible conductor, and furnished at the opposite end with a carbon rod, and in the combination with the said solenoid and carbon-carrying armature of a pair of serrated plates arranged with their faces near each other, but not in contact, one of the plates being connected with the ground, the other being normally in contact with the carbon carried by the armature. It also consists in the combination with the carbon carried by the armature and the carbon lightning arrester plate of a closed chamber which is nearly air-tight, enclosing the upper surface of the plate and the carbon carried by the armature. 3 claims.

23,409. "Improvements in storage batteries." G. A. WASHBURN. Dated December 20th. Consists in a battery in which is employed a porous cup and one or more electrodes on the inside of the cup, and one or more electrodes on the outside of the cup. 1 claim.

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